SEISMIC SAFETY and SAFETY Elements of the County of Alameda General Plan

adopted by County of Alameda
Board of Supervisors
August 5, 1982

Seismic Safety and Safety Elements of the County of Alameda General Plan

Adopted by:
County of Alameda
Board of Supervisors
August 5, 1982

ALAMEDA COUNTY BOARD OF SUPERVISORS

Joseph Bort, Chairman
Fred Cooper
Don Excell
John George
Charles Santana

PLANNING COMMISSION OF ALAMEDA COUNTY

Shirley Douglas, Chairman
Griffeth Tully, Vice-Chairman
Paul Bernhardt
Barbara Shockley
George Spiliotopoulos
Sidney Sutherland
Mary Warren

PROJECT STAFF

Research and Text:	William D. Allin, Planner III Leslie S. Robin, Planner III
Graphics:	Lisa Watkins, Planning Aide
Typing:	Shirley A. Deveno, Stenographer II Joyce G. Tavares, Stenographer II
Project Director:	Betty Croly, Assistant Planning Director
Planning Director	William H. Fraley

Preface

The Seismic/Safety Element of the Alameda County General Plan and the Safety Element of the Alameda County General Plan were adopted in November 1976.

This report updates the Seismic/Safety Element regarding fire hazards, flood hazards, geologic hazards and adds a section on hazardous materials.

The State of California General Plan Guidelines requires their inclusion. The development of these elements incorporates the findings and goals of the General Plan for the Central Metropolitan Eden and Washington Planning Units and the Livermore-Amador Valley Planning Unit General Plan. The Seismic Safety and Safety Elements should be considered in the development of all future plans and programs.

OUTLINE

LIST OF TABLES

LIST OF FIGURES

I. Introduction

A. Scope and Organization

This document comprises the Seismic Safety Element and Safety Element of the County of Alameda General Plan. The Elements include descriptive information, analysis, and policies pertaining to geologic/seismic hazards, flood hazards, and fire hazards within the County. In background sections the Elements provide: a general overview of area geology and seismic history; an assessment of the potential for fault rupture, ground shaking, ground failure, tsunamis and seiches, inundation from dam failures, wildland and urban fires, and flooding; a general identification of hazardous structures and review of potential impacts of earthquakes, floods and fires on land uses, structures, public facilities and utilities; and a review of current state, regional, and local (County, City, service district) programs and policies bearing on the identification of hazards and achievement of health and safety objectives. The policies included in the Elements set forth general and broad goals and objectives, and principles and implementation recommendations which provide more specific direction to current and future actions by public agencies and by the private sector.

This document is organized into five major sections:

Introduction: This section describes the purpose and authority for the report; the relationship of the Elements to other parts of the County Plan; and the responsibilities of the County, the cities within Alameda County, and of other agencies in preparing and implementing the Elements.

Goals: This section presents the overall goals of the Seismic Safety and Safety Elements.

Objectives, Principles, and Implementation Recommendations: This section sets forth the Elements objectives, principles and implementation recommendations for the County and for the unincorporated areas and pertaining to seismic and geologic hazards, wildland and structural fire hazards, flood hazards, and hazardous materials.

Data and Analysis: This section is divided into four major subsections:

Geologic and Seismic Hazards: This section provides a description of area geology and tectonics, an identification of hazards and their effects on land uses, and an identification of measures to mitigate hazards, including a review of regulations, standards and emergency plans.

Wildland and Structural Fire Hazards: This section provides an identification of structural wildland hazards, and discusses hazard mitigation, including a description of fire protection services and facilities.

Flood Hazards: The section includes an identification of hazards-flooding, dam inundation, tsunamis and seiches - and discussion of hazard mitigation.

Hazardous Materials: This section includes a review of agency responsibilities for regulation of the transport, storage and disposal of hazardous materials and wastes.

B. Authority

Government Code Sections 65302(f) and 65302.1 require seismic safety and safety element in all city and county general plans, as follows:

> A seismic safety element consisting of the identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to the effects of seismically induced waves such as tsunamis and seiches.
>
> The seismic safety element must also include an appraisal of mudslides, landslides, and slope stability as necessary geologic hazards that must be considered simultaneously with other hazards such as possible surface ruptures from faulting, ground shaking, ground failure and seismically induced waves.
>
> A safety element for the protection of the community for fires and geologic hazards including features necessary for such protection as evacuation routes, peak load water supply requirements, minimum road widths, clearances around structures, and geologic hazard mapping in areas of known geologic hazards.

The effect of these sections is to require cities and counties to take seismic and safety hazards into account in their planning programs. All seismic and safety hazards need to be considered, even though only certain effects are given as specific examples. The basic objective is to reduce loss of life, injuries, damage to property, and economic and social dislocations resulting from future earthquakes or other natural disasters.

C. County-City Coordination

Preparation of these elements included a review of adopted Seismic and Safety Elements and emergency plans in order to identify hazards, as well as local programs and policies, to mitigate these. As required, local, regional and state agencies have been consulted in the preparation of the Elements.

This Draft document was referred to local, state and regional agencies for review and comment.

D. Relationship to Other Parts of the County of Alameda General Plan

The Seismic Safety and Safety Elements are a part of the County of Alameda General Plan. The two Elements present background data and analysis, and policies and implementation recommendations which supplement materials contained in the several other Elements and documents which, with Seismic Safety Elements, comprise the County's comprehensive General Plan for conservation and development.

E. Risk

The efficiency of seismic safety and safety programs lies in the definition of acceptable levels of risk for the community. The criteria for determining risk is based upon:

- reduction in loss of life and injuries;
- reduction or prevention of property damage, and;
- prevention of economic and social dislocations resulting from future earthquakes.

With these criteria in mind a heirachy of risk may be established.

Risk is here classified in accordance with the definitions contained in the California Council on Intergovernmental Relations, Safety Element guidelines:

<u>Acceptable risk</u>: The level of risk below which no specific action by local government is deemed necessary, other than making the risk known.

<u>Unacceptable risk</u>: Level of risk above which specific action by government is deemed necessary to protect life and property.

<u>Avoidable risk</u>: Risk not necessary to take because the individual or public goals can be achieved at the same or less total "cost" by other means without taking the risk.

At the unacceptable risk extreme are critical structures such as nuclear reactors, dams and other buildings the failure of which would affect substantial populations. At the other extreme would be open space with the highest acceptable risk, where failure would affect practically no structures or persons.

Table 1 relates levels of acceptable exposure to risk to land uses and structures.

II. Comprehensive Goals for the Seismic and Safety Elements

- To reduce the risk of loss of life, property or natural resources due to natural hazards.
- To promote the health, safety and welfare of the population by avoiding or reducing adverse social, economic and environmental effects of natural hazards.
- To educate and inform residents of potential hazards and mitigating measures.

TABLE 1

Levels of Acceptable Exposure to Risk

LEVEL OF RISK	EXPLANATIONS	KINDS OF LAND USES AND STRUCTURES
1. Lowest level of acceptable exposure to risk (Highest level of unacceptable exposure to risk)	Failure of a simple structure may affect substantial populations. Structures whose continued functioning is critical to the community welfare or whose failure might be catastrophic. These structures should experience no structural/mechanical failure or damage to interior equipment. These structures must be fully operational immediately following a major earthquake.	Critical structures such as nuclear reactors, large dams, plants manufacturing or storing explosives or toxic materials.
2. Very low level of acceptable exposure to risk (Very high level of unacceptable exposure to risk)	Failure of a single structure may affect substantial populations. Structures whose use is critically needed after a disaster. These structures must not experience structural/mechanical failure, with little or no damage to interior furnishings and equipment. They must be fully operational following a major earthquake.	Essential structures such as hospital, fire stations, important utility centers, critical transportation elements such as bridges and overpasses, fire, police, and emergency communication facilities.
3. Low level of acceptable exposure to risk (High level of unacceptable exposure to risk)	Failure of a single structure would affect primarily the occupants. Structures of high occupancy or whose use after a disaster would be particularly convenient though not critical. No structural collapse should occur or damage that cannot be repaired quickly.	Occupancy structures such as schools, churches, civic buildings, theaters, large hotels, jails, dormitories, high-rise apartment or office buildings.
4. Ordinary level of acceptable exposure to risk	Failure of a single structure would affect primarily the occupants. No structural collapse should occur; damage may occur to mechanical systems and contents of building.	Relatively low occupancy structures such as most industrial or commercial buildings, small hotels and apartment buildings.
5. More than ordinary level of acceptable exposure to risk	Failure of a single structure would affect primarily the occupants. No structural collapse should occur. Damage may occur to mechanical systems and contents of building.	Single family residences, warehouses, parking structures.
6. Highest level of acceptable exposure to risk		Open Space only.

SOURCE: Meeting the Earthquake Challenge, Final Report to the Legislature, State of California by the Joint Committee on Seismic Safety, January, 1974, California Division of Mines and Geology, Special Publication 45.

III. Objectives, Principles and Implementation Recommendations

A. County-wide

OBJECTIVE: To minimize unacceptable risks, personal injury and loss of life associated with environmental hazards.

1. General Hazards

Principle 1.1 Areas of severe environmental hazards should be protected from land uses, facilities and activities which would aggravate existing hazards or which would subject citizens and property to unnecessary risk.

Implementation:

1.1.1 Undertake studies to identify areas of severe geologic, fire and flood hazards; and evaluate hazards with respect to risk to alternative land uses. Develop standards and guidelines and use as the basis for general plan and zoning land use decisions and more specific development decisions. (City and County Planning Departments)

1.1.2 Require environmental impact studies, including appropriate detailed investigations, for development proposed in areas of known or potential environmental hazards. (City and County Planning and Public Works Departments)

2. Geologic Hazards

Principle 2.2 All new development should be designed and constructed to minimize risk due to geologic and seismic hazards.

Implementation:

2.2.1 Require geologic and/or soils and engineering investigations for development proposed in geologic hazards areas. Condition projects to follow report recommendations. (City and County Planning, Public Works Departments)

2.2.2 Require structures and facilities to be designed and constructed to meet seismic safety and related design requirements of the most recent Uniform Building Code, or more stringent requirements applicable to critical, essential or high occupancy facilities; or an indicated by site investigations. (City and County Public Works Departments)

Principle 2.3 The level of risk from geologic hazards to existing development should be minimized.

Implementation

2.3.1 Undertake studies and develop programs to minimize the risk of potential geologic disasters in areas where severe hazard is present and where human alteration to the environment has already occurred. (City and County Public Works Departments, State)

2.3.2 Pursue current programs or initiate new programs to identify and abate structural hazards, with priority given to the identification and abatement of hazards in critical, essential and high occupancy structures; in structures located within areas of severe geologic hazard; and in structures built prior to enactment of applicable local or state earthquake design standards. (City and County Public Works Departments)

2.3.3 Pursue programs to determine the potential impact of a major earthquake on public facilities. As required, take necessary measures to improve the earthquake performance of these facilities. (City and County Public Works Departments)

2.3.4 Support regional or statewide programs which will assist local agencies in the identification of existing structural or site hazards in private development and which will assist the public and private sectors in the abatement of these hazards. (City Councils, County Board of Supervisors, State Representatives)

2.3.5 Pursue or initiate programs to provide the public with information regarding geoseismic and related structural hazards and appropriate measures to minimize risks of these. (City and County Planning and Public Works Departments, Offices of Emergency Services)

Principle 2.4 Up-to-date information on geologic hazards should be collected on a continuing basis and made available to the public and to other agencies.

Implementation:

2.4.1 Establish a countywide geologic hazard information collection, storage and retrieval system coordinated with state and regional information programs. (County and City Public Works Department)

2.4.2 Develop a seismic educational program for use by schools, developers and the public at large covering hazards, abatements and emergency plans and procedures. (City and County Offices of Emergency Services)

2.4.3 Continue coordination among cities and the County in the development of rational land use policies in light of geologic/seismic hazards; emergency operations plans and emergency preparedness plans. (City and County Planning Departments, Offices of Emergency Services)

2.4.4 Coordinate with responsible officials in the development of emergency preparedness plans for public and private agencies and residential areas. (City and County Planning Department, Offices of Emergency Services, Public and Private Agencies)

3. Wildland and Structural Fire Hazards

Principle 3.1 All County residents and property should be be protected from the hazard of fire through ongoing education programs and regulations.

Implementation:

3.1.1 Require structures, features of structures, or activities determined to be hazardous in terms of fire potential to be brought into conformance with current applicable fire and safety standards. (City and County Public Works Departments)

3.1.2 Develop and implement fire safety education programs. (Fire Departments, School Districts, Parks and Recreation Districts)

3.1.3 Include consideration of fire hazard potential water supply and fuel fighting facilities in all land use decisions. (City and County Planning Departments)

3.1.4 Provide information on fire hazards and fire prevention to decision-makers and to the general public. (City and County Planning Departments, Fire Departments)

3.1.5 Coordinate local and state fire prevention programs and property. (State and Local Fire Departments)

Principle 3.2 Development and activities should be regulated and appropriate additional fire protection measures provided in or adjacent to areas subject to potential severe wildland fire hazard.

Implementation:

3.2.1 Require environmental impact reports to be prepared for projects proposed within or adjoining areas of severe wildland fire hazard. Require projects to follow recommendations for minimizing risks. (City and County Planning Departments; Public Works Departments)

3.2.2 Require all urban and rural development to be provided with adequate water supply and fire protection facilities and services. (City and County Planning and Public Works Departments)

3.2.3 Develop and enforce fire safety standards and criteria (regarding vegetation types and management, building materials, street design, etc.) for development within or adjoining areas of severe wildland fire hazard. Review for consideration Fire Safe Guides for Residential Development in California by California Department of Forestry. (Fire Protection Districts and City Fire Departments, City and County Public Works Departments)

3.2.4 Ensure that privately owned water storage facilities (e.g. reservoirs, swimming pools) in wildland areas are available for use in fire suppression. (City and County Public Works Departments, Fire Departments, Private Sector)

3.2.5 Develop a Wildland Fire Hazard and Severity Map and Classification Study for Alameda County. (Fire Departments)

4. Flood Hazards

Principle 4.1 The level of risk of injury and financial hardship to the public from flood hazard should be minimized.

Implementation:

4.1.1 Regulate the location and design of structures within flood hazard zones. (City and County Planning and Public Works Departments)

4.1.2 Assess potential impacts and, where necessary, require mitigation of projects resulting in major changes in surface water runoff rates and patterns. (City and County Planning and Public Works Departments)

4.1.3 Undertake flood control programs/projects where flooding is a significant hazard in existing developed urban areas. (Alameda County Flood Control and Water Conservation District)

4.1.4 Develop a public education program designed to inform residents of potential hazards and of emergency operations plans. (City and County Offices of Emergency Services)

4.1.5 Develop dam failure and flood plain inundation evacuation plans. (City and County Offices of Emergency Services)

4.1.6 Develop a flood warning system. (City and County Offices of Emergency Services)

Principle 4.2 Where flood control works are necessary, natural watercourse should be preserved in accordance with their ecological significance and with aesthetic principles of channel design.

Implementation:

4.2.1 Consider ecological significance and aesthetic quality of natural drainage ways in the design of all flood control projects. (City and County Public Works Department)

Principle 4.3 Areas subject to flood hazards and dam inundations should be identified and the severity of the hazard determined.

Implementation:

4.3.1 Review and monitor the configuration of flood hazard areas on a continuing basis. (City and County Public Works Department)

4.3.2 Determine degree of inundation hazard created by partial failure of dams. (Office of Emergency Services in coordination with State Division of Safety of Dams)

4.3.3 Examine the potential for geologic hazards to induce dam failure. (Office of Emergency Services in coordination with State Division of Safety of Dams)

5. Hazardous Materials

Principle 5.1 Regulate the location of uses involving the manufacture, storage, use and disposal of hazardous materials; regulate hazardous materials transport, treatment of hazardous materials.

Implementation

5.1.1 The Alameda County Solid Waste Management Authority should cooperate with the State Department of Health Services and other Bay Area Counties to provide for safe storage, transportation and disposal of hazardous materials and waste and to encourage reuse and recycle of these wastes. (Alameda County Solid Waste Management Authority, State Department of Health Services, Police Departments, Fire Departments, and Division of Environmental Health)

5.1.2 Coordinate programs with the functions and regulations of the State Department of Health Services. (City and County Planning Department, Alameda County Solid Waste Management Authority, State Department of Health Services, Association of Bay Area Governments, Police Department, Fire Department, and Division of of Environmental Health)

B. Unincorporated Areas

1. General

OBJECTIVE 1. To minimize the potentially adverse effects of environmental hazards on development; to ensure that all new development is located, designed and constructed to minimize risks of property damage, personal injury and loss of life resulting from an earthquake, landslide, flood or major wildland or urban fire.

Principle 1.1 New development should not be permitted in areas of severe environmental hazards, unless mitigated by proper corrective measures, if such development would 1) subject citizens to unnecessary and unacceptable risk; 2) aggravate existing hazards; and/or 3) entail excessive public expenditures for the installation and/or maintenance of facilities or services or for the provision of emergency services in the event of a natural catastrophe.

Implementation:

1.1.1 Develop specific plans and/or specific policies and guidelines to govern development in areas of severe environmental hazard. (County Planning Department)

1.1.2 Maintain and constantly update an environmental hazards data base to accurately identify hazards. (County Planning Department, County Geologist)

1.1.3 Establish specific standards to define unacceptable risk. (County Planning Department, County Geologist)

1.1.4 Require special studies and investigations in areas of known or potential environmental hazard. (County Planning Department, County Building Inspection Department)

2. Geologic Hazards

OBJECTIVE 2. To minimize the adverse affects of geologic and hazards on residents and property of the incorporated areas of the County.

Principle 2.1 To the extent possible, projects should be designed to accommodate seismic shaking and should be sited away from areas subject to hazards induced by seismic shaking (landsliding, liquefaction, lurching, etc.) where design measures to mitigate the hazards will be uneconomic or will not achieve a satisfactory degree of risk reduction.

Implementation:

2.1.1 Enforce building code provisions requiring soils and/or geologic reports for sites affected by potentially hazardous geologic and soils conditions. (County Building Inspection Department, County Planning Department)

Principle 2.2 All structures should be designed and constructed to withstand groundshaking forces of a minor earthquake without damage, of a moderate earthquake without structural damage, and of a major earthquake without collapse. Critical and essential structures and facilities should be designed and constructed to remain standing and functional following a major earthquake.

Implementation:

2.2.1 Require all new construction to meet the most current, applicable lateral force requirements. (County Building Inspection Department, State Regulatory Agencies)

Principle 2.3 Structures should be located at an adequate distance away from active fault traces, such that surface faulting is not an unreasonable hazard.

Implementation:

2.3.1 Require applications for development within Alquist-Priolo Study Zones to include geologic data demonstrating either that the subject property is not traversed by an active or potentially active fault, or that an adequate setback can be maintained between the fault trace and the proposed new construction. (County Building Inspection Department, County Planning Department)

2.3.2 Require sites to be developed and all structures to be designed and constructed in accordance with recommendations contained in the soil and geologic investigations reports. (County Planning Department, County Building Inspection Department)

2.3.3 Establish standards for development in areas previously in Alquist-Priolo Study Zones, and eliminated in the last update. (County Building Inspection Division)

Principle 2.4 Major transportation facilities (e.g. freeways, rail rapid transit) and underground utilities should be planned to cross active fault traces a minimum number of times and should be designed to accommodate fault displacement without major damage that would cause long term and unacceptable disruption of service. Utility lines should be equipped with mechanisms to shut off flows in the event of fault rupture.

Implementation:

2.4.1 Regulate the extension of utility lines in fault zones. (County Planning Department, County Public Works Agency, Utility Agencies, State Regulatory Agencies)

2.4.2 Establish and enforce design standards for transportation facilities and underground utility lines to be located in fault zones. (County Public Works Agency, Service Agencies, State Agencies)

Principle 2.5 Aspects of all development in hill areas, including grading, vegetation removal, and drainage, should be carefully controlled in order to minimize erosion and disruption to natural slope stability.

Implementation:

2.5.1 Require soils and/or geologic reports for development proposed in areas of erodable soils and potential slope instability. (County Planning Department, County Building Inspection Division)

2.5.2 Require site development and construction to be in compliance with soil and geologic investigations report recommendations. (County Planning Department)

Principle 2.6 Within areas of demonstrated or potential slope instability, development should be undertaken with caution and only after existing geological and soil conditions are known and considered. In areas subject to possible widespread major landsliding, only very low density development should be permitted, consistent with site investigations; grading in these areas should be restricted to minimal amounts required to provide access.

Implementation:

2.6.1 Require soils and/or geologic reports for development proposed in areas of potential slope instability. (County Planning Department, County Building Inspection Department)

2.6.2 Require site development and construction to be in compliance with soil and geologic investigations report recommendations. (County Planning Department, County Building Inspection Department)

Principle 2.7 All existing structures or features of structures which are hazardous in terms of damage, threat to life, or loss of critical and essential function in the event of an earthquake should be brought into conformance with applicable seismic and related safety (fire, toxic materials storage and use) standards through rehabilitation, reconstruction, demolition, or the reduction in occupancy levels or change in use.

Implementation:

2.7.1 Pursue programs to identify and correct existing structural hazards, with priority given to hazards in critical, essential and high occupancy structures and in structures built prior to the enactment of applicable local or state earthquake design standards. (County Building Inspection Department, State Regulatory Agencies)

2.7.2 Support regional or statewide programs providing funding or technical assistance to local governments to allow accurate identification of existing structural hazards in private development and providing assistance to public and private sectors to facilitate and to minimize the social and economic costs of hazard abatement. (County Planning Department, County Building Inspection Department, State Agencies)

2.7.3 Continue to require the upgrading of buildings and facilities to achieve compliance with current earthquake bracing requirements as a condition of granting building permits for major additions and repairs. (County Building Inspection Department)

2.7.4 Continue, and as required, expand programs to provide the public information regarding seismic hazards and related structural hazards. (County Planning Department, Office of Emergency Services)

3. Wildland and Urban Fire Hazards

OBJECTIVE 3. To minimize the level of risk of fire hazard to urban and wildland areas.

Principle 3.1 Urban and rural development and intensive recreational facilities and activities should be discouraged in hill open space areas lacking an adequate water supply or nearby and available fire protection facilities.

Implementation:

3.1.1 Limit or prohibit development and activities in areas lacking adequate water and fire-fighting facilities. (County Planning Department)

Principle 3.2 Hill area development, and particularly that adjoining heavily vegetated open space areas, should incorporate careful site design, use of fire retardant building materials and landscaping, development and maintenance of fuel breaks and vegetation management programs, and provisions to limit public access to open space areas in order to minimize wildland fire hazards.

Implementation:

3.2.1 Enforce design standards and guidelines through the site development, planned development, and subdivision review processes. (County Planning Department)

3.2.2 Require environmental impact assessment for development proposals in areas of severe fire hazard. (County Planning Department)

Principle 3.3 Development should generally be discouraged in areas of high wildland fire hazard where vegetation management programs, including the creation and maintenance of fuel breaks to separate urban uses from wildland areas, would result in unacceptable impacts on open space, scenic and ecological conditions.

Implementation:

3.3.1 Require environmental impact assessment for development proposals in areas of severe fire hazard. (County Planning Department)

3.3.2 Enforce, and as required, revise development standards. (County Planning Department)

Principle 3.4 All urban and rural development, existing and proposed, should be provided with adequate water supply and fire protection facilities and services. Facilities serving hill area development should be adequate to provide both structural and wildland fire protection. The primary responsibility falls upon the owner and developer.

Implementation:

3.4.1 Enforce applicable provisions of the subdivision ordinance. (County Planning Department)

Principle 3.5 Structures, features of structures, or uses which present an unacceptable level of risk of fire should be brought into conformance with applicable fire safety standards.

Implementation:

3.5.1 Enforce applicable provisions of the building code. (County Building Inspection Division)

3.5.2 Encourage fire safety public education and information programs. (County Office of Emergency Services, Fire Protection Agencies)

4. Flood Hazard

OBJECTIVE 4. To minimize the level of risk to residents and loss of property from flood hazards.

Principle 4.1 New structures located within the flood fringe of a one-hundred year flood plain should be flood proofed and designed and located to allow unrestricted flow of flood-waters. New structures should not be permitted in the floodway of a 100-year flood plain.

Implementation:

4.1.1 Enforce applicable provisions of the building code. (County Building Inspection Division)

Principle 4.2 Surface runoff from new development should be controlled by on-site measures including, but not limited to structural controls and restrictions regarding changes in topography, removal of vegetation, creation of impervious surfaces, and periods of construction, such that the need for off-site flood and drainage control improvements is minimized and such that runoff from development will not result in downstream flood hazards.

Implementation:

4.2.1 Require environmental assessment of project impacts. (County Planning Department)

4.2.2 Utilize site development and planned development district review. (County Planning Department, County Building Inspection Division)

Principle 4.3 Structures should generally be located away from shoreline areas subject to tsunami inundation, except where they can feasibly be designed to withstand the effects of inundation.

Implementation:

4.3.1 Require site studies where development is proposed in areas tentatively identified as subject to inundation. (County Planning Department, County Building Inspection Division, Service Agencies)

4.3.2 Require construction to be in compliance with study recommendations. (County Planning Department, County Building Inspection Division, Service Agencies)

5. Hazardous Materials

OBJECTIVE 5. Reduce the level of risk from hazardous materials and wastes to the unincorporated areas in Alameda County.

Principle 5.1 Uses involving the manufacture, use or storage of highly flammable (or toxic) materials and highly water reactive materials should be located at an adequate distance from other

uses and should be regulated to minimize the risk of on-site and off-site personal injury and property damage. The transport of highly flammable materials by rail, truck, or pipe-line should be regulated and monitored to minimize risk to adjoining uses.

Implementation:

5.1.1 Enforce applicable provisions of zoning ordinance and building code. (County Planning Department, County Building Inspection Division)

5.1.2 Utilize zoning to segregate potentially hazardous uses. Hazardous materials uses should be located so that they are not affected by disasters such as fire, flood, and earthquakes. (County Planning Department, Police Departments, Fire Departments, and Division of Environmental Health)

5.1.3 Enforce the Alameda County Solid Waste Management Plan. (County Planning Department, Alameda County Solid Waste Management Authority)

IV. Data and Analysis

A. Geologic-Seismic Hazard

1. Geologic and Tectonic Setting

a. Geomorphology

Alameda County is located in the San Francisco Bay Region of Central Coastal California. Principal physiographic features include the Bay plain and the Diablo Range. The Diablo Range, a mountainous area extending in a northwesterly to southeasterly direction, includes all of the California Coast Range east of the San Francisco Bay basin and the Santa Clara Valley. The Diablo Range is not continuous, but is broken by erosion and local structural variations. Topography throughout much of the range consists of northwest to southeast trending ridges and intervening, steep-sided, narrow valleys. An exception to this pattern is the broad, east-west trending Livermore-Amador Valley which is surrounded by gently rolling hills to the north, east and immediate south. A steep, northwest to southeast trending ridge system separates the Livermore-Amador Valley from the San Francisco Bay basin. A broad, gently sloping alluvial plain extends westward from the base of the Diablo Range west to San Francisco Bay.

b. Area Geology

The bay plain and the valley areas of Alameda County are underlain by Quaternary (from the present to 2 to 3 million years ago) unconsolidated deposits which, in turn, are underlain by sedimentary metamorphic and igneous rocks of up to 150 million years in age. The Quaternary deposits consists primarily of alluvial and estuarine sediments. The alluvial ranges from stream deposited sands, gravels, silts, clays and intermixtures to fine wind blown sand. Estuarine sediments consist of silty clays and some sand and shell layers deposited in the bay and marshlands. Adjacent to San Francisco Bay the younger alluvial deposits grade into younger bay mud, a variable, semi-fluid to firm silty clay with lenses of water-saturated fine sand. Younger bay mud is locally overlain by landfills that vary from dense, engineered fills to trash accumulations of uncertain geotechnical properties.

The Oakland-Berkeley Hills and the main Diablo Range are underlain by bedrocks of various types and age. Almost all of the hills have a mantle of topsoil and weathered bedrock. These soil materials vary in depth from a few to many feet and present a potential slope stability hazard. Where the bed-rock is well bedded and erosion of man-made excavation under-cuts the bedding slope stability problems exist.

c. Tectonics

1) Causes and Terminology

An earthquake is a release of stored energy from the earth's crust. The energy is released along a fault or plane of weakness between two large masses of the earth's crust or outer surface. The crust, about 10 to 15 miles thick in the Alameda County area, is fractured along fault lines. At a global scale, for reasons that are not fully understood, the pieces of the earth's crust are moving. Typically, two crustal masses move past one another at a rate less than an inch per year.

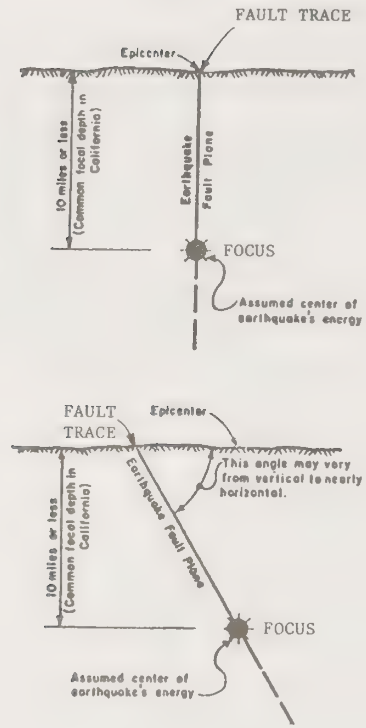
The more generally held theory of the cause of earthquakes is the elastic rebound theory. As two crustal masses move by one another, strong and protruding sections on both sides of the fault become locked together by friction, preventing further movement at that point on the fault. The two crustal masses continue to move elsewhere and begin to build up stress and strain in rocks at the point where the two crustal masses have locked. The rocks are compressed, or sheared and stretched, like giant springs, storing some of the energy that moves the crustal masses. This phase, in which the two sides of the fault are locked together and stress builds in the rocks, may last from a few weeks to over one hundred years.

The section of a fault that is locked has to withstand the forces applied by the continuing movements of the two crustal masses. Inevitably, the cross-fault connection will be broken and the energy stored in the rocks released; this is the event call an earthquake. If the cross-fault connection is weak, the crustal forces will only be accumulated for a short time until they are sufficient to break the connection and cause a mild earthquake. Should the cross-fault connection be strong, the crustal forces may build up over a long time period before they are strong enough to break the connection and this will result in a major release of energy, a major earthquake.

The line where a fault plane intersects the earth's surface is called a fault trace (See Figures 1 & 2). The location on the fault where maximum energy is released is called the earthquake focus. The depth of the focus below the earth's surface is normally 10 miles or less, with the average depth being closer to 5 miles in California. The point on the ground surface directly above the earthquake focus is called the epicenter. The epicenter will seldom coincide with the trace of the causative fault because the planes of most faults are not perpendicular to the earth's surface. Instead, most fault planes tilt or dip to one side of the surface fault trace.

Figure 1

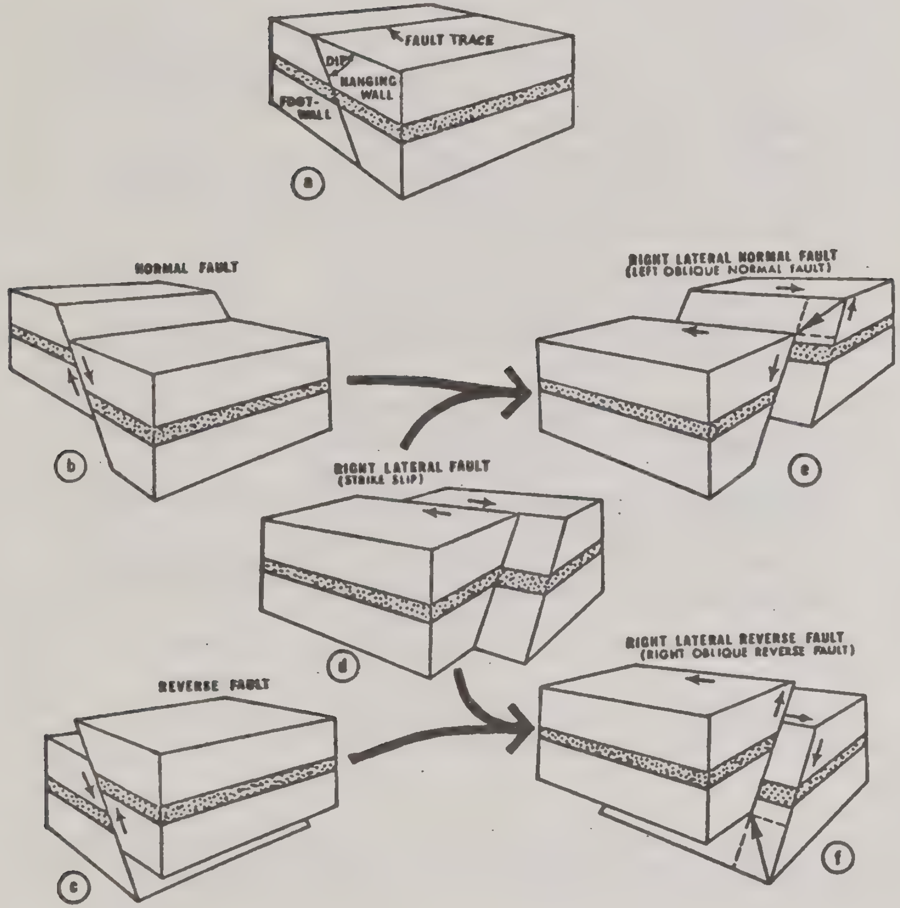
Two Idealized Earthquake Faults



Source: Earthquake Hazards in the San Francisco Bay Area, Steinbrugge

Figure 2

Types of Fault Movement



Source: Hayward Earthquake Study, April 1972

The energy release of an earthquake results in some movement of the two crustal masses with respect to each other; sometimes the movement is apparent at the ground surface (See Figure 2). The movement is abrupt during an earthquake. The relative movement or faulting has been sub-divided by direction of movement. The horizontal movements tend to be much greater than the vertical movements in the San Francisco Bay Area. The horizontal shift is repeated in the same direction each time; when standing on one side of the fault, the other side will move repeatedly to the right or to the left the major faults in California move to the right which is called right-lateral movement.

The energy released in an earthquake ranges from an amount so small that is goes unnoticed except by the most sensitive instruments to an amount so large that it can destroy any structures within its range.

"Earthquake magnitude, the amount of energy released by a quake, was originally defined in 1935 by Professor Charles F. Richter of the California Institute of Technology in Pasadena. The Richter scale is logarithmic, with each whole number representing a magnitude of energy release that is approximately 31.5 times the lower number. This means, for example, that there is 31.5 times more destructive energy in an earthquake of magnitude 6 than in one of magnitude 5.

"Intensity scales measure the effects rather than the energy release of an earthquake. There are several intensity scales, all based on reports of ground and building damage and on interviews with people in different locations in the earthquake-affected areas. These scales were developed as the only means of evaluating the relative size of an earthquake before earthquake-recording instruments were available. Various categories of earthquake damage, ground effects, and personal sensations, emotions and observations were defined and were assigned numerical designations. Because the categories are mainly related to effects on people and buildings, intensity scales have become known as the 'manscaring, structure-busting' earthquake scales.

"The Modified Mercalli (MM) intensity scale is the one most commonly used in the United States. The MM scale is denoted with Roman numerals from I to XII, with each number corresponding to descriptions of earthquake damage and other effects."[1] (See Table 2)

[1] Peace of Mind in Earthquake County, Peter Yanev, 1974, p 36

TABLE 2

MODIFIED MERCALLI SCALE OF INTENSITY**

I. Not felt. Marginal and long-period effects of large earthquakes.

II. Felt by persons at rest, on upper floors, or favorably placed.

III. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a ball striking the walls. Standing motor vehicles rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frames creak.

V. Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken, knicknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D* cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle).

VII. Difficult to stand. Noticed by drivers of motor vehicles. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along stand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

VIII. Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Declayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX. General panic. Masonry D destroyed; masonry B seriously damaged. (General damage to foundations). Frame structures, if not bolted, shifted off foundations. Frames cracked. Serious damage to reservoirs.

Underground pipes broken. Conspicuous cracks in ground. In alluviated areas, sand and mud ejected, earthquake fountains, sand craters.

X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks to canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.

XI. Rails bent greatly. Underground pipelines completely out of service.

XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

---

* Masonry A, B, C, D.: To avoid ambiguity of language, the quality of masonry, brick or otherwise, is specified by the following lettering (which has not connection with the conventional Class A, B, C construction).

Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

**1957 version, from "Elementary Seismology" by C.F. Richter, W.H. Freeman and Co., Inc. 1958.

The Modified Mercalli Intensity (MMI) scale is a subjective scale. The first five levels (I through V) do not involve damage to facilities or economic loss under normal circumstances. Levels VI through X are characterized by increasing damage to engineered facilities, economic loss, and human casualties. Levels XI and XII relate primarily to ground surface effects rather than response of buildings.

"Because the damage and ground effects are influenced by numerous factors, such as distance from the causative fault, local geology and ground conditions, the type of soil beneath the observer, the accuracy of the personal observations, etc., reported intensities vary considerably from site to site.

"Since earthquake effects vary with these many factors, an earthquake cannot be assigned a single intensity number, of course. Instead, the earthquake intensities observed at various locations are plotted on an intensity or isoseismal map.

"Because the MM intensity scale and the Richter magnitude scale measure entirely different parameters, it is very difficult to compare the two. The magnitude scale records physical energy with instruments and therefore gives no consideration to the important factor of geologic conditions. The intensity scale, on the other hand, is necessarily less than precise since it is based solely on personal observations."[1]

The Table 3 provides a crude reference to the relationship between the two measures.

2) Regional Tectonics

The California Coastline, including the Bay Area, is located within the Circum-Pacific Seismic Belt, where over 80% of the world's earthquakes occur.

Note: Sections on Seismic Hazards, Seismic Hazards in Alameda County, and portions of Planning Considerations in the 1975 Seismic Element were prepared by David Carpenter, Engineering Geologist, Alameda County Public Works Agency.

[1]Yanev, p 42

TABLE 3

COMPARISON OF MAGNITUDE, INTENSITY, AND EFFECTS

Magnitude	Intensity (MM)	Effects
1	I	Observed only instrumentally.
2	I-II	Can be barely felt near epicenter.
3	III	Barely felt, no damage reported.
4	V	Felt a few miles from epicenter.
5	VI-VII	Causes damage.
6	VII-VIII	Moderately destructive; some severe damage.
7	IX-X	Major, destructive earthquake.
8	XI	Great earthquake.

Source: Peter Yanev, Peace of Mind in Earthquake Country, p 46

The San Francisco Bay Region has experienced about 12 damaging earthquakes in the past century. Based on studies of geodetic measurements across the major fault zones, seismicity and calculated rates of strain accumulation, it seems reasonable to expect a great earthquake (comparable to the San Francisco earthquake of 1906) once in 60 to 100 years (Oakeshott, 1969). The history of great earthquakes in the world indicates that there is no regular periodicity, so it is obvious that such figures cannot be used for earthquake prediction, but only for expected frequency. However, all evidence points to the conclusion that areas of historically high seismicity are the places where damaging earthquakes are likely to center in the future.

A summary of locations of major earthquakes in the Bay Area is shown in Figure 3 and 4. The historical record contains five entries generally accepted to be the largest known shocks in the Bay Area. These are as follows:

1. June 10, 1836, on the Hayward fault. At 7:30 a.m., cracks and fissures opened up along this fault from San Pablo to Mission San Jose.

2. June, 1838, probably on the San Andreas fault. A fissure was described as extending from near San Francisco to near Santa Clara.

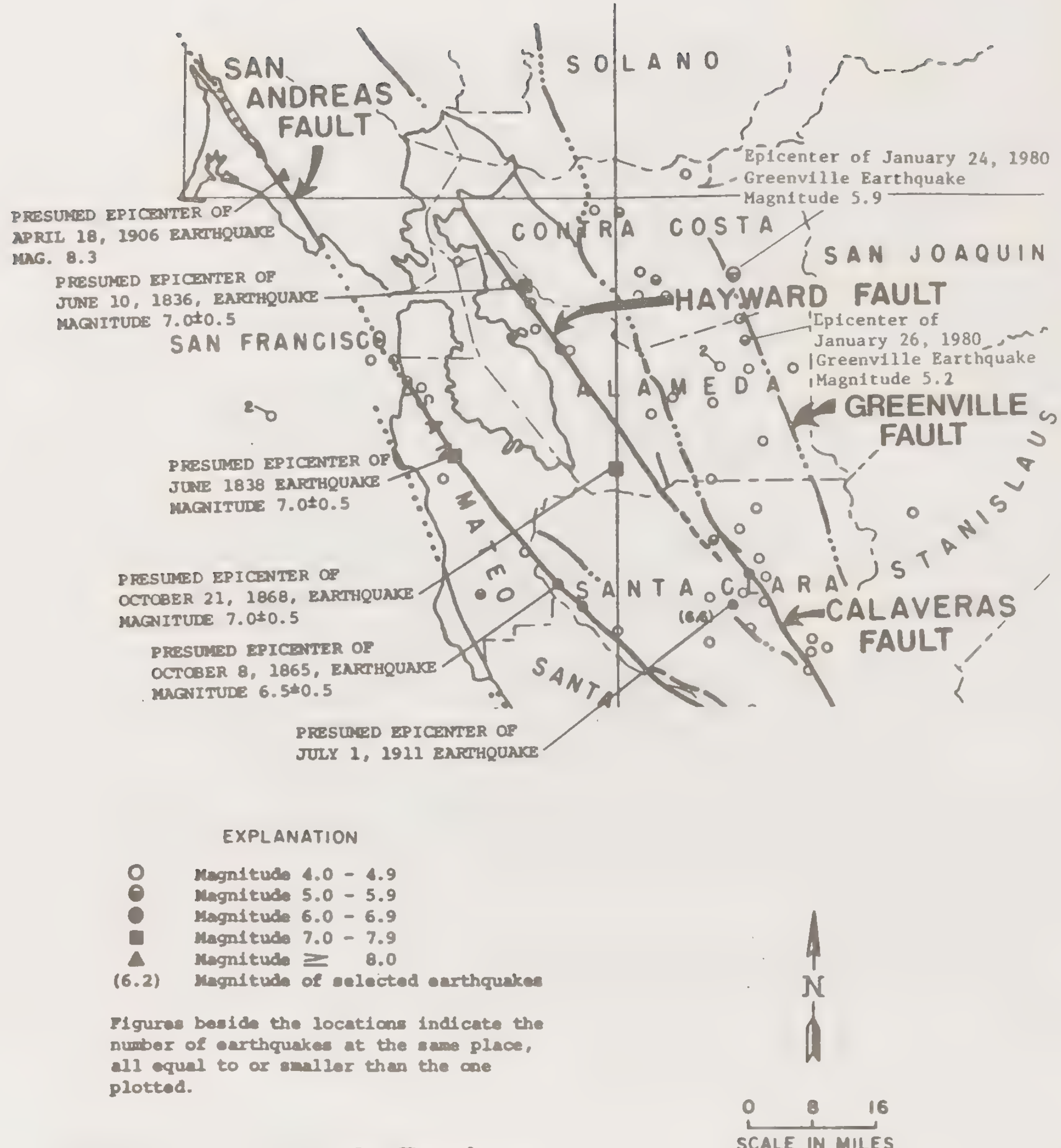
3. October 8, 1865, probably on the San Andreas fault. Considerable damage occurred in San Francisco. The earthquake presumably had its epicenter on the San Andreas fault in the Santa Cruz Mountains.

4. October 21, 1868, on the Hayward fault. At 7:52 a.m., cracks and fissures from this earthquake formed from about San Leandro to about Warm Springs. Very heavy damage occurred in the town of Hayward, and there was also extensive damage in sections of San Francisco.

5. April 18, 1906, on the San Andreas fault. At 5:13 a.m., the well known San Francisco shock occurred. Faulting extended from southern Humboldt County to near San Juan Bautista in San Benito County.

Although all of these earthquakes were undoubtedly of different Richter magnitudes, they all appear to have been of sufficient size to approach or equal the maximum

Earthquake Hazards in the San Francisco Bay Area, Steinbrugge, 1968

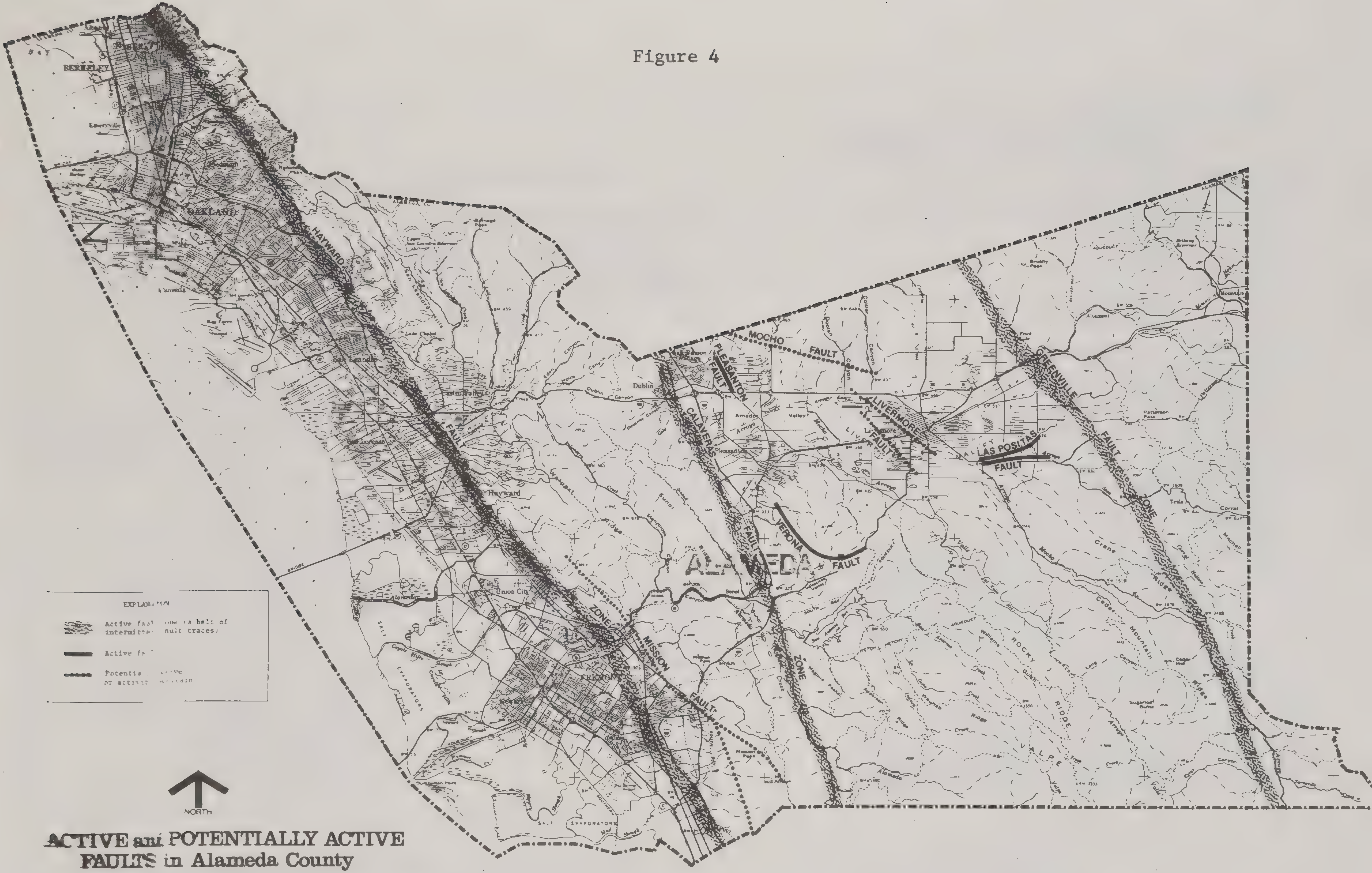


ACTIVE FAULTS in the Bay Area

Figure 3

Regional Seismicity Map on Plate 2, Special Report 107 California Division of Mines and Geology
T. H. Rogers and J.W. Williams (1974) (1980 Modifications - Alameda County Public Works Agency)

Figure 4



ACTIVE and POTENTIALLY ACTIVE FAULTS in Alameda County

From Plate , California Division of Mines and Geology Open File Report, OFR81-3 SF (1981)

probable future earthquake intensities to be expected in at least major sections of the San Francisco Bay Area. Instrumental data do not exist for the pre-1906 shocks, and even the historical data are meager for the 1836 and 1838 shocks.

The more significant earthquakes that have occurred in the Bay Area during the period 1950 to present are listed in Table 4.

Table 4

Recent Bay Area Earthquakes of Magnitude 5 Since 1950

Date	Location	Richter Magnitude
April 25, 1954	Watsonville	5.3
September 4, 1955	San Jose	5.8
October 24, 1955	Walnut Creek	5.4
March 22, 1957	Daly City	5.3
April 8, 1961	South of Hollister	5.6
September 14, 1963	Chittenden	5.4
October 1, 1969	Santa Rosa	5.7
February 24, 1972	Hollister (15 miles from)	5.1
November 28, 1974	Hollister	5.25
August 6, 1979	Gilroy	5.9
January 24 & 26, 1980	Livermore	5.9 & 5.2

Considerable damage occurred in Santa Rosa during the October 1, 1969 event and groundshaking was sufficiently violent to cause the collapse of open utility trenches as far away as Pleasanton (Burkland & Associates, 1975). Locally significant damage occurred in Gilroy during the August 6, 1979 event. The January 24 and 26, 1980 events were associated with the Greenville Fault, which was previously considered potentially active.

3) Fault Systems — Alameda County

Table 5 summarizes the fault activity classification utilized by Woodward-Lungren and Associates in its analysis of geologic hazards in Alameda County. Table 6, which classifies active and potentially active fault systems in the County, is drawn from reports of the California Division of Mines and Geology (1981).

a) Active Fault Systems

i. <u>Hayward Fault</u>: The known active southern end of the Hayward Fault is between Warm Springs and Milpitas.

Table 5

A SYSTEM FOR CLASSIFICATION OF FAULT ACTIVITY BASED ON AVAILABLE DATA

<table>
<tr><th rowspan="2">ACTIVITY CLASSIFICATION AND DEFINITION</th><th colspan="3">CRITERIA</th></tr>
<tr><th>HISTORIAL</th><th>GEOLOGICAL</th><th>SEISMOLOGICAL</th></tr>
<tr><td>ACTIVE - A FAULT WHICH HAS EXPERIENCED DISPLACEMENT OF SUFFICIENT GEOLOGIC RECENCY TO SUGGEST THAT THERE IS POTENTIAL FOR DISPLACEMENTS IN THE NEAR FUTURE.</td><td>(1) SURFACE FAULTING AND ASSOCIATED STRONG EARTHQUAKES,
(2) TECTONIC FAULT CREEP, OR GEODETIC INDICATIONS OF FAULT SLIP.</td><td>(1) GEOLOGICALLY YOUNG* DEPOSITS HAVE BEEN DISPLACED OR CUT BY FAULTING,
(2) FRESH GEOMORPHIC FEATURES CHARACTERISTIC OF ACTIVE FAULT ZONES PRESENT ALONG FAULT TRACE,
(3) PHYSICAL GROUND-WATER BARRIERS PRODUCED IN GEOLOGICALLY YOUNG* DEPOSITS.
*THE EXACT AGE OF THE DEPOSITS WILL VARY WITH EACH PROJECT AND DEPENDS UPON THE ACCEPTABLE LEVEL OF RISK AND THE TIME INTERVAL WHICH IS CONSIDERED SIGNIFICANT FOR THAT PROJECT.</td><td>EARTHQUAKE EPICENTERS ARE ASSIGNED TO INDIVIDUAL FAULTS WITH A HIGH DEGREE OF CONFIDENCE.</td></tr>
<tr><td>POTENTIALLY ACTIVE - A FAULT WHICH HAS NOT RUPTURED IN HISTORIC TIME, BUT FOR WHICH AVAILABLE EVIDENCE INDICATES THAT RUPTURE MAY HAVE OCCURRED IN THE RECENT GEOLOGIC PAST AND THE RECURRENCE PERIOD COULD BE SHORT ENOUGH TO BE OF ENGINEERING SIGNIFICANCE.</td><td>NO RELIABLE REPORT OF HISTORIC SURFACE FAULTING.</td><td>(1) GEOMORPHIC FEATURES CHARACTERISTIC OF ACTIVE FAULT ZONES SUBDUED, ERODED, AND DISCONTINUOUS.
(2) FAULTS ARE NOT KNOWN TO CUT OR DISPLACE THE MOST RECENT ALLUVIAL DEPOSITS, BUT MAY BE FOUND IN OLDER ALLUVIAL DEPOSITS.
(3) GROUND-WATER BARRIER MAY BE FOUND IN OLDER MATERIALS.
(4) GEOLOGICAL SETTING IN WHICH THE GEOMETRIC RELATIONSHIP TO ACTIVE OR POTENTIALLY ACTIVE FAULTS SUGGESTS SIMILAR LEVELS OF FAULT ACTIVITY.</td><td>ALIGNMENT OF SOME EARTHQUAKE EPICENTERS ALONG FAULT TRACE, BUT LOCATIONS ARE ASSIGNED WITH A LOW DEGREE OF CONFIDENCE.</td></tr>
<tr><td>ACTIVITY UNCERTAIN - A FAULT FOR WHICH INSUFFICIENT EVIDENCE IS AVAILABLE TO DEFINE ITS RECENT LEVEL OF ACTIVITY OR ITS RECURRENCE INTERVAL. A FAULT SHOULD BE CONSIDERED TENTATIVELY ACTIVE, UNTIL PROVEN OTHERWISE, IF IT MAY BE SIGNIFICANT TO THE PROJECT.</td><td colspan="3">AVAILABLE INFORMATION IS INSUFFICIENT TO PROVIDE CRITERIA THAT ARE DEFINITIVE ENOUGH TO ESTABLISH FAULT ACTIVITY. THIS LACK OF INFORMATION MAY BE DUE TO THE INACTIVITY OF THE FAULT OR DUE TO A LACK OF INVESTIGATIONS NEEDED TO PROVIDE DEFINITIVE CRITERIA.</td></tr>
<tr><td>INACTIVE - A FAULT ALONG WHICH IT CAN BE DEMONSTRATED THAT SURFACE FAULTING HAS NOT OCCURRED IN THE RECENT GEOLOGIC PAST, AND THAT THE RECURRENCE INTERVAL IS LONG ENOUGH TO BE OF NO ENGINEERING SIGNIFICANCE.</td><td>NO HISTORIC ACTIVITY</td><td>GEOMORPHIC FEATURES CHARACTERISTIC OF ACTIVE FAULT ZONES ARE NOT PRESENT AND GEOLOGICAL EVIDENCE IS AVAILABLE TO INDICATE THAT THE FAULT HAS NOT MOVED IN THE RECENT PAST AND RECURRENCE IS NOT LIKELY DURING A TIME PERIOD CONSIDERED SIGNIFICANT TO THE SITE. AGE OF MOST RECENT FAULT OFFSET SHOULD BE DOCUMENTED: HOLOCENE, PLEISTOCENE, QUATERNARY, TERTIARY, ETC.</td><td>NOT RECOGNIZED AS A SOURCE OF EARTHQUAKES.</td></tr>
</table>

SOURCE: Woodward-Lundgren & Associates, <u>Phase I - Preliminary Evaluation of Geologic Problems in the County of Alameda</u>, December 1973

Table 6

STATUS OF ACTIVE AND POTENTIALLY ACTIVE FAULTS IN ALAMEDA COUNTY

FAULT	CLASSIFICATION[1]	CRITERIA FOR CLASSIFICATION
Hayward	Active	Historical surface faulting, strong earthquakes
Calaveras	Active	Historical surface faulting, strong earthquakes
Greenville	Active	Surface faulting 1980
Las Positas	Potentially Active	Displacement of dated alluvium
Pleasanton	Potentially Active	Tectonic fault creep, ground water barrier
Mission	Potentially Active	Geological setting, microearthquake epicenters
Verona	Potentially Active	Offset of soil deposits
Livermore	Potentially Uncertain	Ground water barrier in Tertiary-Quaternary gravels
Mocho	Activity Unknown	Ground water barrier in Tertiary-Quaternary gravels

[1] Active and Potentially Active faults are within Alquist-Priolo Act Special Studies Zones.

Sources: Woodward-Lungren, 1973, "This is not necessarily a complete listing. Additional information investigations may establish other faults in the county to be active or potentially active, or may prove that some of the faults on this list are not active."

The fault extends northwesterly through Fremont, Union City, Hayward, San Leandro, Oakland and Berkeley in Alameda County, then northerly into Contra Costa County.

Two of the five recorded major earthquakes in the Bay Area have been correlated with the Hayward Fault (Steinbrugge, 1968) within Alameda County (1836 and 1838). Damage to structures as a result of tectonic creep along the fault has been confirmed (U. S. Geological Survey, 1966); creep monitoring studies by the U.S. Geologic Survey showed an average of 6 millimeters per year of right lateral movement (Burford, 1975).

Ground rupture accompanied the 1836 and 1868 earthquakes (Steinbrugge, 1968). Geotechnical studies by private consulting firms document offsets of recent soil layers along traces of the Hayward Fault.

Detailed evaluation of the Hayward Fault system (Woodward-Clyde and Associates, 1970) indicates that the maximum credible earthquake expected would have a Richter magnitude of 7.5 and be accompanied by up to 7 feet of horizontal and 1½ feet of vertical offset. The maximum historic earthquake (1868 event) was estimated to have had a Richter magnitude of 6 3/4 and was accompanied by 3 feet of horizontal and one foot of vertical displacement.

ii. Calaveras Fault: The Calaveras Fault joins the San Andreas Fault a few miles south of Hollister. It extends in an almost straight line north-northwesterly through Coyote Reservoir, Calaveras Reservoir, past Sunol and parallel to Interstate 680 through Dublin . In the vicinity of San Ramon, the fault trace is less well defined toward the Lafayette-Walnut Creek area.

Evidence for active seismicity along the Calaveras Fault within Alameda County is provided by offset of soil layers along a trace of the fault system in the Dublin area (California Division of Mines and Geology, 1981).

Evidence for tectonic creep on the Calaveras fault has been reported in the Sunol Area (Nason, 1975) and in the Dublin-Camp Parks Area (Gibson and Wollenberg, 1968). The fault is considered a right lateral slip system (U.S.G.S. 1980).

The maximum credible earthquake anticipated for the Calaveras Fault system is 7.5 (Greensfelder, 1974). No estimates are currently available as to the amount of horizontal and vertical ground displacements that could accompany such an event.

iii. Greenville Fault: On Janaury 24, 1980, a magnitude 5.9 earthquake occurred on the Greenville Fault approximately 11 miles north of Livermore. On January 26, 1980, the Valley was shaken again by a magnitude 5.2 earthquake with its epicenter approximatley 4 miles NNE of Livermore.

The Greenville Fault runs along the eastern edge of the Livermore Valley. The southern half of the fault zone exhibits evidence of large areas of massive landsliding. The Greenville Fault extends from Contra Costa County, across Alameda County to northeastern Santa Clara County for a distance of 30 miles.[1] A special studies zone is proposed for the fault.

"Re-examination of earthquake locations in the vicinity of the January 24, 1980 magnitude 5.9 earthquake shows that some earthquakes from the period 1969-1979 occurred within the aftershock volume of the 1980 earthquake. This event ruptured strands of the fault

[1] Hart, 1981, Fault Evaluation Report FER-117, California Division of Mines and Geology.

mapped by Herd (1977) and triggered seismic activity along an 18 mile portion of the fault. Had the January 1980 earthquake sequence not occurred, or if its relationship to the Greenville fault been unclear, the fault would have not been reclassified as active."[1]

Fault movement show it as a right slip fault (USGS 1980).

iv. Las Positas Fault: This fault has been mapped for about 2½ miles, extending northeastward from Mines Road south of Tesla Road to Greenville Road south of East Avenue. Both this trace and a southern branch which runs north of Tesla Road between Las Positas Avenue and Greenville Road have evidence of being active faults and a Special Studies Zone is proposed to encompass the branches.[2]

Motion data are consistent with left lateral slip on a vertical plane parallel to the strike of The Las Positas Fault (USGS 1980).

b) Potentially Active Faults

i. Verona Fault: What is called the Verona Fault runs in a general northwest to southeast direction in the area of the Vallecitos Nuclear Center. There has been extensive landsliding in the area resulting in features identified as faults by some geologist and as slip planes of landslides by others. On the basis of criteria used in 1974, a Special Studies Zone was designated for the Verona Fault. Since 1977 extensive investigations have been done for the General Electric Test Reactor regarding the Verona Fault. The California Division of Mines and Geology has evaluated the available information and although the fault is in doubt, a modification of the Special Studies Zone is proposed because of uncertainty.[3]

[1] United States Geological Survey, Seismicity within the Livermore Valley, California Region 1969-1979, May 1980 p 16.

[2] Smith, 1981, Fault Evaluation Report, FER-112, California Division of Mines and Geology.

[3] Smith, 1981, Fault Evaluation Report FER-104.

The Special Studies Zone extends from Sycamore Road, Pleasanton to State Route 84 about 3½ miles to the southeast.

ii. Pleasanton Fault: The Pleasanton Fault was initially classified as active by the U.S. Geological Survey (Brown, 1970) and by the State of California (Slosson, 1974). Evidence for activity of the Pleasanton Fault consisted of a tentative correlation of a swarm of small earthquakes near Danville with the Pleasanton Fault (Brown and Lee, 1971) and reported evidence of creep in the Dougherty Hills north of Camp Parks (Slosson, 1974).

The re-evaluation of the Pleasanton Fault by the California Division of Mines and Geology concludes that "no evidence for faulting could be detected in the alluvium of Livermore Valley."[1] This includes deep trenching across previously suspected traces. The recommendation for the 1982 official Special Studies Zones Map is that only the Camp Parks area be zoned and that is on the basis of no definitive data on hand to deny the presence of an active fault.

iii. Mission Fault: This fault system has been mapped traversing the Mission San Jose and Niles areas of Fremont east of Mission Boulevard. Through the Union City hills it is mapped as two roughly parallel traces and an associated perpendicular fault trace (Union City Geologic and Seismic Hazards Investigation). Topographic features commonly associated with active faults are not present along the Mission Fault. The U.S. Geological Survey has plotted earthquake epicenters on this fault in Fremont, about 5 miles south of Union City.

[1]Hart 1981, Fault Evaluation Report, FER 109 and communication between Hart and Ed Denehy, (1981).

A Special Studies Zone associated with the Mission Fault was established by the State of California. However, recent studies (Union City and Fremont Seismic and Safety Element Reports, 1975) have failed to confirm the California Division of Mines and Geology re-evaluated the Mission Fault and concluded that the Special Studies Zone designation be deleted[1] as a recent geologic feature.

2. Criteria

a. State and Regional Criteria

Hazards of potential statewide critical concern include the following:

1) Earthquake Shaking: Any locality which can expect earthquake shaking equivalent to a Modified Mercalli Intensity of IX (plus many lesser earthquakes).

2) Landslides: Areas containing at least five percent of geologic formational units judged to fall in units 5 or 6 (most landslides) on a six-unit scale devised by Radbruch and Crawther.

3) Subsidence: Areas in which subsidence is known to have occurred.

4) Erosion Activity: Areas where the soil loss is equal to a more than 6.4 acre feet of soil lost per square mile per year.

5) Expansive Soil: Areas where the soils contain more than 40 percent or more mixed or montmorillonitic clay, or with a coefficient of linear expansion greater than 0.006 inches per inch.

Hazards of regional concern include areas with earthquake related hazards:

1) Lands within 100 feet of a known active fault trace.

2) Lands likely to be associated with a San Francisco intensity of A or B from ground shaking as related to materials and distance from active faults by Borcherdt and Gibbs (1975).

3) Lands underlain by loose, saturated materials likely to liquefy in a major earthquake.

[1]Hart, 1979, Fault Evaluation Report FER-88.

b. County of Alameda Criteria

Geologic hazards of significant County concern include the following:

1) Fault Displacement: Areas within the vicinity of active or potentially active fault traces, including, but not limited to, areas within Special Studies Zones as defined by the State Geologist.

2) Ground Shaking: Areas which would experience very strong shaking during a major earthquake on any of the Bay Area faults, including, but not limited to, areas underlain by poorly consolidated alluvial deposits.

3) Ground Failures: Areas subject to soil liquefaction, lurch cracking, lateral spreading in the event of an earthquake within the Bay Area, including, but not limited to, those underlain by unconsolidated or poorly consolidated, saturated soils.

4) Landsliding: Areas subject to landslides, rock falls, avalanches and mud and debris flow.

5) Structural Hazards: Any critical, essential or high occupancy structures subject to failure or severe disruption in the event of an earthquake.

3. Identification of Hazards - Alameda County

a. Surface Faulting

Fault rupture, which begins at the focus of an earthquake, may extend to the ground surface, especially in moderate to large earthquakes. The direction of separation of the earth on opposite sides of the fault plane may be vertical, horizontal or oblique.

Within Alameda County, fault rupture has been documented along the Hayward Fault, as a result of earthquakes in 1836 and 1868, and possibly on the Calveras Fault, correlated to the earthquake of 1861. A good correlation exists between fault related features in the Dublin area and the trace of the Calaveras Fault and this appears to mark the recent rupture zone along the Calaveras Fault. Studies have located lines of ground rupture on the Hayward Fault (California Division of Mines and Geology, 1981).

While it is generally assumed that surface rupture may be expected to be repeated along active fault traces, the historic record in California is too short to provide conclusive support to this belief. However, a recent study of surface faulting in Owens Valley, where arid conditions and lack of development permit preservation of surface features presents geologic evidence of repeated recent movements along a single fault trace (Slemmons, 1975).

Studies by Woodward-Clyde and Associates (1970) have provided estimates of amounts of horizontal and vertical deformation that may accompany a major earthquake on the Hayward Fault. Based upon these estimates, they have made recommendations for safe setbacks for various types of structures in an area of Fremont. Other consultants have made similar estimates of building setbacks for various locations along the Hayward and Calaveras Fault systems. Such site specific studies are also required of the Greenville, Las Positas, and Verona Faults also.

b. Tectonic Creep

"'Tectonic creep' is the term used to identify fault displacement which occurs at a very slow rate as a consequence of tectonic forces. It has been considered by geologists that such creep relieves some of the build-up of strain along a fault and reduces the likelihood of large energy releases and hence large magnitude earthquakes."[1]

Tectonic creep has been documented along the Hayward and Calaveras Fault systems within Alameda County. Creep on the Hayward Fault has resulted in building damage at several locations in the East Bay as a result of structural distortions caused by relative ground movements on opposite sides the active fault.

Creep appears to be concentrated along relatively narrow zones and is frequently episodic in character (Nason and others, 1974). Creep areas along active faults may be identified in advance of construction by such features as offset fence lines and road centerlines or distortions in repeated survey measurements. Damaging effects of creep can be minimized by suitable setbacks from active fault traces as located during detailed geotechnical investigations.

c. Subsidence

Permanent uplift and subsidence were observed over large areas in Alaska following the great earthquake in 1964. Many coastal areas were submerged or brought within the zone of tidal influence while shoaling of harbors occurred at other locations. Similar regional movements have not been experienced following major Bay Area earthquakes where offsets are largely lateral.

Seed (1969) has stated that it is prudent to consider the potential for one to two feet of vertical displacement adjacent to the Bay as a result of regional ground movements following major earthquakes.

[1] Seismic Safety Element, San Mateo County-City Planning Department

d. Ground Shaking

Ground-shaking--the earthquake itself--consists of complex surface wave motion which has traveled through the rock materials of the outer crust. Earthquake waves, like other waves, may be reflected, refracted, attenuated, and change velocity and period as they pass through different materials, thus making the ground motion complex. In general, earthquake waves, in passing from more dense solid rock to less dense alluvial and water-saturated materials, tend to become reduced in velocity, increased in amplitude, and accelerations become greater. Ground motion lasts longer on loose water-saturated, incompetent materials than on rock, it is also amplified to an unknown extent. Due to a combination of factors, structures located on such materials suffer far greater damage than those located on solid rock.

Many earthquakes have shown that "poor ground" is a greater hazard than proximity to the fault and epicenter. There is some evidence to show that ground motion tends to increase with the depth of alluvium.

Considerable differences were noted in amount of ground shaking in downtown San Francisco during the great earthquake in 1906 and were related to areas underlain by fills versus those on bedrock.[1] Attenuation of ground shaking occurs with distance from an earthquake epicenter. However, little attenuation is observed within about 15 miles of a major fault during a major earthquake (Seed, 1969). Potentially damaging ground shaking could be experienced as far east as the Livermore Valley during an earthquake of magnitude 7.0 or greater on the San Andreas Fault, which is located west of Alameda County. Therefore, all urbanized portions of the County would experience strong ground shaking during a major earthquake on any of the Bay Area faults. Some systematic attenuation of ground motion is possible in lightly settled areas in eastern Alameda County and the potential for damage correspondingly reduced. However, since the Greenville Fault is active, strong, locally-generated groundshaking could be experienced in eastern Alameda County as well.

The bay margin areas of Alameda County cities have the highest level of susceptability due to estuarine and alluvial sediments which are poorly consolidated. These areas are generally west of I-580 and Mission Boulevard. The areas of lowest susceptibility are the hill areas which are underlain by bedrock.

[1]Borcherdt, R.D., editor, 1975, Studies for Seismic Zonation of the San Francisco Bay Region; U.S. Geological Survey Professional Paper, 941-A

e. Ground Failures

Historical ground failures in Alameda County from past earthquakes are presented on Figure 5 (explanations of each failure are described in Appendix 3). Ground failure is defined as a permanent ground movement which includes liquefaction, lurch cracking, differential settlement, landsliding and lateral spreading.

1) Liquefaction

Liquefaction is the transformation of a granular material from a solid state into a viscous liquid state as a consequence of increased pore pressures. The factors affecting it include depth to water table, thickness and location of granular layers, relative density of granular layers, maximum acceleration produced by earthquake shaking, and number of cycles of strong earthquake shaking.

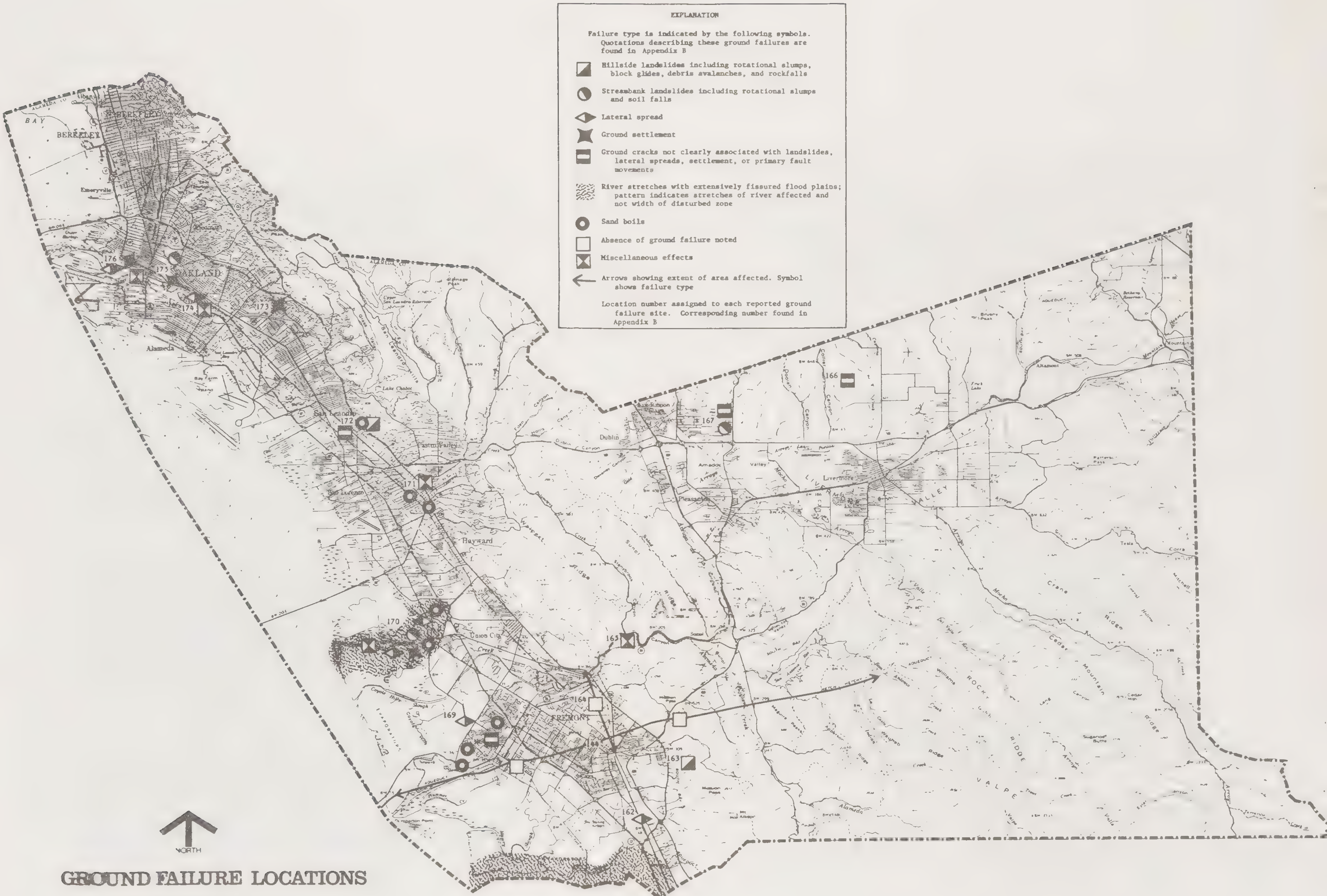
If loose or medium dense, water-saturated, cohesionless soils (such as sands) are subjected to earthquake vibrations, they may compact resulting in an increase in pore water pressure and a resulting movement of water from the voids (Seed, 1969). Water is thus caused to flow upward to the ground surface resulting in a "quick" or liquefied condition. During such an event heavy structures may sink or rotate while light structures such as fuel tanks or utility lines may rise to the surface.

Areas in Alameda County potentially subject to liquefaction are those underlain by unconsolidated, sandy subsoils with a relatively high water table. Studies by the State of California (1974) indicate a liquefaction potential for alluvial deposits with a water table within 50 feet of the ground surface - most of the Bay Plain, western Livermore Valley and Las Positas Valley - but studies by the U.S. Geological Survey (Youd, 1973) indicate that areas of moderate to high liquefaction potential in the Bay Plain are limited to portions of the Plain where depths to ground water are 10 feet or less.

2) Lurch Cracking

The development of all types and sizes of irregular fractures, cracks, and fissures -- largely as the result of sliding, settling and shaking, and the passage of surface earthquake waves--is characteristic, to a greater or lesser extent, in all earthquakes large enough for significant ground motion to occur. Such fractures may be many feet long and may displace surface weathered rock and soil both horizontally and vertically, just as true fault movement would. Lurch cracks rarely occur in solid rock; they are essentially confined to weathered rock, alluvium, and soil. Their patterns may be completely irregular or may

Figure 5



GROUND FAILURE LOCATIONS in Alameda County

Alameda County Planning Department – Policy Planning & Research Division, February 1982

SOURCE: Historic Ground Failures in Northern California Triggered by Earthquakes, J.L. Youd and S.N. Hoose, 1978

show marked regularity where controlled by shallow bedrock, by the outline of natural or artificial fill, by highway surfacing, etc. Lurch cracking is often accompanied by sand boils and mud volcanoes as groundwater moves to the surface. Extensive and damaging lurch cracking has occurred in incompetent water-saturated materials in all moderate to large earthquakes (Magnitudes 6 to 8).

Such cracking could be a major damage factor in many areas of bay mud and in future earthquakes of moderate to large magnitude in, or near, the bay. Lurch cracking may occur in water-saturated sediments, soils, and alluvium at distances up to 75 miles from the epicenter, as demonstrated most recently in the Alaskan earthquake. There is some evidence to indicate that lurch cracking is perhaps most extensive in the deeper alluvial materials.

In Alameda County, lurch cracking is most likely to be observed in areas of liquefiable soils, outlined above, but random cracking following a major earthquake may be observed widely within the County following a major earthquake.

3) Differential Settlements

Compaction of poorly consolidated cohesionless soils as a result of earthquake vibrations has been widely observed (Seed, 1969). Either reasonably uniform or differential ground settlements will be observed as a result of this process. Widespread settlements will have effects similar to those resulting from regional tectonic subsidence while differential movements will lead to building damage and tilting.

Regional compaction settlements are important only if ground level changes result in inundation of areas previously above Bay or reservoir levels, and could result in areas already below high tide levels but protected by levees when such settlement lowers the levee tops to or below high tide levels.

Differential settlements would likely be observed in areas subject to soil liquefaction. This effect might also occur in other portions of the Bay Plain and Livermore Valley underlain by poorly consolidated younger alluvial fan deposits. It would appear that damage and collapse and life safety hazards arising from differential settlements would be greatest in buildings containing several structural elements, e.g. a pier or pile outer foundation with internal columns supported on a slab would be an extreme case.

4) Landslides

Landslides, rock falls, avalanches, mud and debris flows and soil slips falls are examples of downslope movement of earth materials which can be triggered by seismic or non-seismic events. Non-seismic landslides can be triggered by events such as heavy rainfall, gravity, and human alterations of the natural landscape.

Landslides are a major effect of ground shaking in earthquakes of magnitude 5 and greater, especially where slopes are oversteepened from whatever cause, and where earth materials are water-saturated from artificial means or the natural rainy-season. An immense amount of sliding takes place during large earthquakes. State Highway 1, on the coast south of San Francisco, was closed by large landslides in the small earthquake of 1957. The San Andreas, Hayward, and Calaveras fault zones are marked by a succession of many geologically-recent slides, many of them highly unstable. The steep hills on both sides of the Bay are particularly vulnerable to sliding.

Maps based on photo-interpretation (Nilsen, 1973) show moderate to large-sized landslides within Alameda County. These and maps of adjacent areas have been analyzed (Wight and Nilsen, 1974) to provide a summary of landslide frequency on a regional basis. The resultant data indicate that within Alameda County areas of relatively high landslide frequency occur in hill areas northeast of Castro Valley and north of I-580, in the Dougherty Hills north of the Livermore Valley and are a general condition in the Diablo Range in southern Alameda County. Seismically induced slope failures may be most common in these areas during a major earthquake.

Sliding is also anticipated widely along the west side of the San Leandro and Hayward Hills during a major earthquake on the Hayward Fault in response to high ground accelerations that are anticipated in this area. A major earthquake on the Calaveras Fault could trigger widespread movements on the east side of Pleasanton Ridge for the same reason.

Failure of steep slopes and collapse of natural stream banks could occur widely during a major earthquake. Threats to structures would be greatest in areas where homes encroach closely on natural channels or are situated on potentially unstable slopes.

Structural damage or collapse could occur either as a result of loss of support from beneath a building or inundation by debris from above. Serious interference with east-west movements of emergency vehicles following a major earthquake should be anticipated. Natural and cut slopes along Crow Canyon Road, I-580 and Niles Canyon Road, the only east-west traffic corridors providing efficient access between the Bay Plain and the Livermore Valley, are likely to fail extensively in response to earthquake vibrations. Unless the large viaduct on I-580 in Altamont Pass collapsed, it is probable that emergency vehicles from the San Joaquin Valley could reach eastern Alameda County following an earthquake disaster. However, help coming from the east for the Bay Plain might be impossible for a critical interval owing to landsliding in the East Bay Hills.

5) Lateral Spreading

If liquefaction occurs in or under a sloping soil mass, the entire mass will move laterally toward any unsupported face such as a stream bank or excavated channel. Lateral spreading may occur as small cracks, with a slight displacement of the ground, or as violent and complicated deformation of the surface, usually accompanied by cracks and open fissures. These cracks and fissures cut the ground into strips and prisms which lurch toward the stream trench or slough, usually accompanied by rotation of the prism. Such movements have been observed in natural materials and fills (Seed, 1969). Within Alameda County, they may occur in areas subject to soil liquefaction and will most probably occur adjacent to stream and flood control channels in western Livermore Valley and along floodways in the Bay Plain.

Structural damage and building collapses could occur during such movements with corresponding threats to life safety.

4. Effects on Land Uses, Structures, and Facilities

a. Fault Rupture and Ground Failures

Should foundation materials supporting structures fail because of fault rupture or ground failures, then the structures may be subject to excessive forces and serious damage or collapse, and threat to life would result. The potential amounts of displacement on the Hayward, Calaveras and Greenville Faults could result in the collapse of rigid concrete or steel buildings located directly on fault traces, as well as severe damage to total collapse of wood frame structures. Heavy structures located on seismically liquefied soils may sink or rotate, while light structures, such as fuel tanks and utility lines, may rise to the surface. Severe damage may occur in either case. Lurch cracking may contribute to structural damage and collapse, if cracks in ground materials propagate into building foundations. Similarly, structural damage and building collapse could occur due to lateral spreading of soil masses. In areas of high landslide potential, structural damage or collapse could occur either as a result of loss of support from beneath a building, or from inundation by debris from above. Collapse of natural stream banks could also occur during a major earthquake. Threats to structures would be greatest where these encroach closely on the creek bed.

b. Ground Shaking

The majority of structures in Alameda County are subjected only to earthquake vibrational forces, or ground shaking; and the potential for damage and the risk to human life varies considerably according to type of construction.

A substantial number of structures within the County were built before local buildings codes required earthquake bracing. Of these, small wood frame structures are least likely to collapse from earthquake shaking. However, older wood frame structures with inadequate foundation to frame connections, or which are weakened by rot or termite infestation, may break from their footings, generally rupturing all utility connections.

Unreinforced brick, stone or block buildings are the most failure-prone structures. Reinforced block and concrete construction can be designed to be highly earthquake resistant, although, as shown by the San Fernando area earthquake of 1971, this type of construction may fail when connections between walls, roof and floors are not strong enough to resist shaking forces. Ductile concrete frame design is considered equivalent to steel frame design for buildings up to fourteen stories.

Steel frame buildings can be designed to withstand strong shaking, and are the preferred type of construction for buildings of fourteen stories and over in seismically active areas. Light steel frame and glass buildings with reinforced concrete roofs could, like tilt-up structures, suffer severe damage or collapse due to weak connections between the structural members.

1) Hazards to Private Development-Residential, Commercial and Industrial Uses

The County and several of the cities in the County have attempted, primarily through use of 1970 Census housing data (age and type of structure), to estimate the approximate number of potentially hazardous residential structures within their respective jurisdictions. Without extensive field investigation, however, and without detailed evaluation of potentially hazardous structures by qualified engineers and geologists, it is not possible to accurately define existing structural hazards within the County.

Most local jurisdictions adopted strong earthquake bracing provisions around 1950, and have subsequently used these and more recent amendments to the building code to regulate new development. However, these requirements were not intended to be retroactive; although most building codes allow the local building official to require abatement of existing structural hazards. Due to local staffing or funding limitations and to a lack of federal, state or local programs to minimize possible social and economic impacts on private property owners, there has been little aggressive hazard abatement. The more common method for upgrading the safety of buildings has been to require improvements when building permits are issued for additions or repairs. The Uniform Building Code calls for compliance of existing as well as new construction with <u>all</u> current code requirements if the work being done exceeds fifty percent of the value of the existing structure.

a. Residential Structures

There are approximately 444,886 residential units in the County (January 1980 estimate). Of these, 263,348 are single family, detached structures. Another 175,591 are in multi-unit structures, including an estimated 29,060 in two unit buildings, 30,903 in three and four unit buildings, and 115,628 in structures of 5 units or more. Single family structures and small duplex, triplex and fourplex structures are typically of one or two story, wood frame construction. Except where directly affected by ground rupture, landsliding, or extremely high ground acceleration, collapse or total destruction of small wood frame residential structures would be rare, even in strong earthquakes. Other types of damage can be expected, including falling chimneys, breaking glass, falling furniture, cracked and falling plaster or facing materials, and broken utility connections.

Larger apartment buildings are of more varied construction. The relative potential for damage of buildings not containing earthquake bracing is greater in large area, multi-story wood frame structures than in smaller wood frame residential buildings, and greater still in unbraced steel, concrete and masonry structures. The greatest number of older multi-unit residential structures are in the cities of Oakland, Berkeley and Alameda, which were extensively urbanized before 1950.

b. Commercial and Industrial Structures

Commercial and industrial structures vary considerably as to size and type of construction. Smaller, one and two story wood frame structures can be expected to show fair performance in an earthquake, except where directly subject to ground failures or surface rupture. Newer, single-story buildings of wood frame or tilt-up construction should be expected to sustain moderate damage, or possibly severe damage where roof-to-wall connections in tilt-up buildings are not adequate to assure public safety.

Older commercial buildings are primarily concentrated within the central business areas and along major thoroughfares in the north and central parts of the County. These areas also include the greatest concentrations of older, unbraced masonry buildings which have the highest potential for earthquake damage or collapse. A significant hazard presented by such structures is the potential failure of unreinforced walls and particularly unreinforced parapets.

Industrial structures can present significant hazards to occupants due to the mechanical equipment which might be affected by earthquake shaking, and to the toxic and/or flammable materials in storage or utilized in manufacturing processes.

2) Hazards to Public Facilities

a) Public Buildings

Public Schools

These facilities vary as to size and type of construction. Schools built since enactment of the Field Act in 1933 have been designed to meet earthquake resistance standards established and enforced by the state. Pre-Field Act facilities have been replaced or remodeled, in compliance with more recent provisions of the California State Education Code. Since 1970 new state requirements have also required consideration of special earthquake hazards of a geologic nature, including faulting and soil liquefaction, and established provisions relating to soils and geologic engineering investigations of proposed school sites.

Major Health Facilities

The Office of Statewide Health Planning and Development, Division of Facilities Development establishes design standards, including those relating to earthquake forces, utilized in the construction of hospitals and other major health facilities. The Division administers

legislation which, since 1973, has required that all major health facilities be designed and constructed so as to remain standing and functional following an earthquake. These provisions relate to both site geologic conditions and to building and equipment design. Because the legislation is not retroactive, the Division is limited to recommending to local health agencies actions necessary to evaluate and abate hazards or potential hazards in health facilities constructed prior to 1973.

Based on a geological report and a structural engineering study, Alameda County has developed a program for the present and future of the Fairmont Hospital/Juvenile Hall complex. The program includings relocating people, closing certain buildings and repairing buildings.

b) Transportation Facilities

. Streets and Highways

The principal effects of a major earthquake on the streets and highways system would include localized earth failures due to surface rupture, landsliding, or subsidence, and damage to and possible collapse of bridge structures.

Within areas subject only to ground shaking, streets and highways are not expected to sustain major damage. In areas of weak soils, such as recently deposited alluvium and bay mud, facilities may be expected to experience some differential subsidence. Earth fills underlying much of the Eastshore Freeway, as well as approaches to the San Francisco-Oakland Bay Bridge, Dumbarton Bridge and Hayward-San Mateo Bridge may be subject to extensive slippage and differential settlement during strong ground motion.

There is a high possibility of major landslides under conditions of heavy ground motion in hill areas. These could block portions of several major arterials and freeways, including portions of Interstates 580 and 680, and Niles Canyon Road.

All of the Warren Freeway, and portions of Interstates 580 and 680 are within the corridor of the Hayward Fault. Portions of these freeways are constructed over potentially active fault traces. In the event of a major earthquake, damage to these freeways could be extensive. A number of freeway interchanges and overpass structures are also located on or near to traces of the Hayward Fault and would probably be heavily damaged in a major earthquake if large displacement occurs along the fault.

The performance of freeway structures in the San Fernando area earthquake of 1971 indicates that similarly constructed overpasses and interchanges in the planning area are equally susceptible to damage or failure in very strong ground shaking. The State Department of Transportation evaluated most highway bridges, identified those which are potentially unsafe, and is undertaking a program to make corrections and improve the earthquake performance of these structures.

. Bay Area Rapid Transit

The BART system was designed and constructed with considerable attention to reduction of seismic hazards. All of the BART alignment was designed based on soil investigation, however, some built upon structurally poor soils where ground subsidence may occur, and the BART tracks can be expected to be distorted by even a moderate earthquake, with potential for derailment of high-speed trains. This problem was initially identified by BART engineers, and the District has subsequently responded to install sensors along the system to detect seismic motion, and to develop and implement procedures to guard against derailment of and damage to BART trains in the event of an earthquake. These include restrictions on train movement in the event of an earthquake until tracks have been inspected and any distortions or other damage corrected.

. Railroads

Most tracks should sustain little damage due to ground shaking. The major risk involves damage to elevated structures, to trackage, or grade separations affected by fault slippage or rupture. It is expected that service will be disrupted where lines cross the Hayward and Calaveras Faults. These offsets may be spectacular, but can be quickly repaired because of level terrain. It is also possible that ground failures could damage bridges and trestles located on weak soils, such as saturated bay muds and recently deposited alluvium.

- Airport and Port Facilities

  Oakland port and airport facilities are situated on fill overlying bay mud. Soils in these areas could be subjected to very heavy shaking during a major earthquake, and some damage to port and airport facilities may be expected.

c) Utilities

- Gas and Electric Lines

  The most serious damage to transmission lines can be expected in areas subject to ground rupture and severe ground failure. Disruption of gas and electric utility service is probable in hill areas traversed by the Hayward and Calaveras Faults and/or subject to seismically induced landsliding. Landsliding and major ground subsidence are generally the direct cause of gas pipeline breaks. Some gas lines have been designed to withstand some fault displacement without major damage, and most are equipped with valves which will shut off flows given any significant change in pressure.

  Damage to electric and gas lines can also be expected where these are located in highway or other bridge structures subject to extensive damage or collapse during an earthquake.

- Fuel Pipelines

  Damage to major gas and oil pipelines can be expected where these lines cross the active faults, or where the lines are located in soils subject to lurch cracking, subsidence, or landsliding. Most gas lines are equipped with automatic shut-off valves. Flows in lines carrying refined petroleum products are regulated by manually operated block valves. (See Hazardous Waste section for regulations.)

- Water Supply Facilities

  In areas subject only to ground shaking, interruption of water supply by broken mains is generally considered potentially slight. If in relatively good physical condition, most pipelines are flexible enough to withstand ground shaking without significant damage.

  Fault rupture, landsliding, and major ground subsidence induced by shaking are generally the direct cause of most pipeline breaks. Damage due to subsidence may be expected where pipelines are in saturated soils along stream channels, or in saturated alluvium and bay mud where shaking is of long duration and results from low frequency, high amplitude seismic waves.

  Many water distribution systems have been designed to withstand some fault displacement without damage. The Hetch Hetchy system, for example, was built with expansion joints where it crosses the Hayward Fault. However, it is not known whether this or other similar facilities could withstand an offset of three feet, the amount experienced in the earthquake of 1868. In some areas, such as the East Bay Municipal Utilities District service area, water supply facilities have been developed on both sides of the Hayward Fault in order to allow water supply to bypass lines damaged by surface rupture and to minimize disruption of service.

  Large lakes and reservoirs are under the jurisdiction of the State Division of Dam Safety. The Division has inspected facilities in the County, has required the local responsible agency to make necessary modifications where necessary to ensure against damage or collapse during an earthquake.

  Several smaller water storage facilities are located within the active zone of the Hayward Fault, and are particularly susceptible to damage in the event of surface rupture.

- Sanitary Facilities

  Damage to sewage collection systems would be minimal in areas subject only to ground shaking, and moderate to severe where lines are subject to landsliding and subsidence. Sewage treatment plants would generally suffer damage similar to that experienced by similarly constructed and equipped industrial plants, including damage to machinery and equipment. Almost all treatment plants along the Bay plain are located over recently deposited alluvium of Bay mud, which materials are subject to moderate to high liquefaction and which are likely to experience ground subsidence during a major earthquake.

- Drainage Facilities

  Earthen banks and levees of flood control channels could slump into waterways under

seismic loading, resulting in the obstruction of flow routes along the channels. Deviation or obstruction in channels due to earth slumping could increase risks of inundation to adjacent lands. Also regional compaction settlement could result in a hazard in areas already below high tide levels. The normal flow in drainage systems could also be altered by damage to storm drains crossing faults, damage to pumping stations and tide gates, and loss of slope in channels or drains due to ground settlement or uplift.

- Solid Waste Disposal Sites

  The Alameda County Solid Waste Management Authority's County Plan identifies contingency sites for disposal in case of disruption of transfer stations and/or landfill operation. This contingency plan does not specifically address debris removal or the possible need for increased capacity to handle debris in the event of an earthquake.

5. Mitigation of Hazard

a. State of California

State Legislation addressing seismic and geologic hazards include the following:

- Sections 65302(f) and 65302.1 of Government Code require seismic safety and safety elements in all city and county general plans.

- Sections 660-662 and 2621-2625 of the Public Resources Code require the State Geologist to delineate special studies zones encompassing potentially and recently active fault traces (Alquist-Priolo Act).

  The Code prohibits the construction of most structures intended for human occupancy on or across the traces of active faults and requires local governments to implement programs to precisely locate fault traces and to regulate development with the mapped zones.

  The official State Special Studies Zone issued January 1982 include the Calaveras Fault, Hayward Fault, Greenville Fault, Las Positas Fault, and Verona Fault within Alameda County.

- Sections 2700-2708 of the Public Resources Code require the Division of Mines and Geology to purchase and install strong motion instruments (to measure the effects of future earthquakes) in representative structures and geologic environments throughout the State.

- Section 15002.1 of the Education Code requires that geological and soil engineering studies be conducted on all new school sites and on existing sites where deemed necessary by the Department of General Services.

- Sections 15451-15466 of the Education Code require that public schools be designed for the protection of life and property (Field Act).

- Sections 15000 et seq. of the Health and Safety Code require that geological and engineering studies be conducted on each new hospital or additions which affect the structure of an existing hospital.

- Sections 19100-19150 of the Health and Safety Code require certain buildings to be constructed to resist lateral forces. (Riley Act)

- The National Flood Insurance Program covers losses due to "mudslides" (i.e., the flow of liquid mud down a hillside) even though no mudslide-prone areas have been delineated by Federal Emergency Management Agency (FEMA). This insurance coverage is not applicable to landslides, rock falls, avalanches, or soil slips.

b. County of Alameda

1) General Plan

Alameda County has adopted a Seismic Safety Element (January 1976), Safety Element (January 1976), and Conservation Element (November 1976), including specific seismic safety and safety goals and policies. This present Element updates the 1976 Elements.

Also by the end of 1977, all the cities in the County had adopted Seismic Safety, Safety and Conservation Elements.

2) Building Code

Section 2905 of the Alameda County Building Code requires applicants for new construction to submit soils and/or geologic reports for sites affected by a number of geologic and soils conditions including the presence of primary and secondary seismic hazards. The Code, as amended October 1, 1977, also requires soils and/or geologic investigations for all A-1, A-2, A-2.1 and H-1 occupancies (e.g. assembly halls,.....) (See Figure 6).

3) Zoning Ordinance

With the exception of the Alquist-Priolo Act, the present Ordinance does not contain any earthquake regulations. The Alquist-Priolo Act designates special studies zones (fault zones) within which structures for human occupancy must be subjected to evaluation by a certified engineering geologist. Results of studies based on geologic investigation should be used to revise the Zoning Ordinance.

Figure 6

Section 2095 of the Alameda County Building Code
(effective October 1, 1977)

Section 2905 Soils and Geologic Investigation.

(a) When Required. A soil and/or geologic investigation shall be required in the following circumstances.

1. For all A-1, A-2, A-2.1 and H-1 Occupancies.
2. When the allowable soil pressure used in the design of the foundation exceeds 2,000 psf.
3. When the building is proposed to be supported in fill.
4. When the slope of the natural ground within 30 feet of any building or structure exceeds 20 percent and the slope is more than 10 feet in height.

   EXCEPTION: For R-3 Occupancies, foundation plans and retaining structures designed by a registered engineer may be substituted for a soil and geologic investigation on sites where the slope exceeds 20 percent but is less than 35 percent and where no other provisions of this Section apply.

5. When a cut or a fill exceeding 5 feet in depth at any point either exists or is proposed and the slope of the natural ground within 30 feet of the building or the cut or fill exceeds 10 percent and the slope is more than 10 feet in height.
6. Where highly expansive or erodible soils are present unless it can be demonstrated to the satisfaction of the Building Official that the structure will not bear on such soils.
7. In any subdivision into five or more parcels as defined in Section 8-1.3 of the Alameda County Subdivision Ordinance which has been recorded after September 17, 1965. Where highly expansive soils or other soil conditions are present within a subdivision, which if not corrected would lead to structural defects, a soil and/or geologic investigation report shall be required for each lot in the subdivision.
8. On a building site traversed or suspected to be traversed by a potentially active fault.
9. In areas of known or suspected geological hazards, including landslide hazards and hazards from earthquake caused ground shaking.
10. When otherwise required by the Building Official due to proposed design of the structure or due to topographical or geological conditions on the building site.

   EXCEPTION: A soil investigation shall not be required for additions to existing dwellings or for M Occupancies.

(b) Investigation. Those portions of the investigation that are civil engineering as defined by Section 6734 of the Business and Professions Code of the State of California shall be prepared by a Soils Engineer who is a Civil Engineer registered by the State of California. Those portions of the investigation that involve the practice of geology as defined by Section 7802 of the Business and Professions Code of the State of California shall be prepared by an Engineering Geologist registered and certified by the State of California.

The investigation shall be based on observation and tests of the materials disclosed by boring or excavation made in appropriate locations. Additional studies may be necessary to evaluate soil strength, the effect of moisture variation on soil, bearing capacity, compressibility and expansiveness.

(c) Reports. The soil and geologic investigation report shall contain all of the following as they may be applicable to the particular site and any recommendations contained therein shall be subject to the approval of the Building Official.

1. A description, location, and a reference elevation of all borings or excavations measured to the nearest one foot.
2. A classification of the soil.
3. Pertinent laboratory test data.
4. If the soil is classified as expansive, the report shall include special recommendations as to the design of foundations and concrete slabs supported on the ground in order to eliminate detrimental effects on the foundation or slabs.
5. A description of ground water conditions if they exist.
6. A recommendation as to method for excavating and compacting soils.
7. A recommendation regarding drainage and erosion control.
8. A recommendation as to setback for buildings or structures from top or toe of slopes.
9. A recommendation as to the allowable soil pressure to be used in design of any proposed building or structure.
10. A recommendation as to the lateral soil pressure to be used in the design of retaining or basement walls if any such walls are proposed.
11. A recommendation as to the design of foundations if such foundations are proposed to be located partly on natural soil and partly on fill soil.
12. An evaluation of the expected settlement of any fill and any proposed building or structure.
13. An evaluation of the stability of any natural slope and any proposed or existing cut and fill slope.
14. An index map showing the regional setting of the site.
15. A description of the geology of the site and the geology of adjacent areas if the adjacent geological features affect the site.

   A suitably scaled map and cross section shall be included in reports wherein the hazard of surface fault rupture is specifically discussed or where areas of land slippage have been identified.

16. A description of the geological investigative techniques employed.
17. If geological hazards exist, the report shall include recommendations to mitigate these hazards.
18. A professional engineering and geologic opinion as to the safety of the site from the hazards of land slippage, erosion, settlement or seismic activity.

The site development and all buildings and structures shall be designed and constructed in accordance with the recommendations contained in the soil and geologic investigation reports.

(d) Final Report. Upon completion of rough grading work and prior to the approval of the foundation for any proposed building or structure, the following shall be provided.

1. When required by the Building Official an as-built grading plan prepared by a registered Civil Engineer including original ground surface elevations, as-graded ground surface elevations, lot drainage, and location of all surface and subsurface drainage facilities.
2. A complete record including location and elevation of all field density tests, and a summary of all field and laboratory tests.
3. A declaration by the Civil Engineer and Geologist in the form required by the Building Official that all work was done in accordance with the recommendations contained in the soil and geologic investigation reports as approved by the Building Official and the approved plans and specifications.

   Where soil or geologic conditions encountered in grading operations are different from that anticipated in the soil and geologic investigation reports or where such conditions warrant changes to the recommendations contained in the original soil investigation, a revised soil or geologic report shall be submitted for approval and shall be accompanied by an engineering and geologic opinion as required in Section 2905(c), Item 18.

The Alquist-Priolo Act designates special studies zones (fault zones) within which structures for human occupancy must be subjected to evaluation by a certified engineering geologist. Results of studies based on geologic investigation should be used to revise the Zoning Ordinance.

4) Grading Ordinance

The Alameda County Grading Ordinance has been adopted effective April 15, 1982. The Ordinance establishes minimum standards and provides regulations for grading, construction and maintenance of landfills and excavation and for control of erosion and sediment.

5) Subdivision Ordinance

The existing County Subdivision Ordinance contains the necessary provision for requiring a soils report to be prepared by a soils and foundation engineer, a geologic report prepared by an engineering geologist, an erosion control report, and a grading plan prepared by a licensed civil engineer. Soils and geological reports will be used as part of the Countywide data system.

6) Hazards Mapping/Investigations

In December 1973, Woodward-Lundgren and Associates, Inc., provided the Alameda County Public Works Agency with Preliminary Geologic Hazards Maps covering most of the County at a scale of 1 inch equals 2000 feet. These maps, when combined with other geotechnical data and site reconnaissances, are generally adequate to determine the need for a detailed, site-specific soil and/or geologic report. Such detailed reports are prepared by private engineering and geologic consulting firms and reviewed for technical adequacy by the Building Official and the County Engineering Geologist.

Funds were included in the Public Works Agency fiscal year 1976 budget to permit revision and upgrading of a portion of the map set under the supervision of the County Engineering Geologist. This second phase included preparation of Natural Slope Stability maps for Dublin, Hayward and Niles quadrangles. The revised report, issued October 1977, included a strong-motion instrumentation program assessment of natural slope stability and investigation to identify geologic problems.

7) Emergency Operations Plan

In July 1978, Alameda County adopted an Earthquake Response Directive to be incorporated into the County Emergency Operations Plan (updated March 1980). The Directive applies fully to the unincorporated area and to the contract cities of Berkeley, Emeryville, Hayward, Newark, Piedmont, Pleasanton, San Leandro and Union City. Albany, Alameda, Fremont, Livermore and Oakland have developed their own emergency plans.

However, in the event of an emergency, each city is responsible for its own jurisdiction. The County is responsible for providing or coordinating assistance when local resources are exhausted.

The Earthquake Response Directive includes a checklist of vital emergency actions that all jurisdictions should be prepared to undertake in response to a major earthquake. Emergency operations are based on five emergency conditions, A to E. Condition A is a general preparedness or stand - by condition based on the assumption that a serious earthquake will occur in the future, even though the exact time and place of such an earthquake are unknown. Conditions B, C, D and E describe situations prevailing after a particular earthquake has occurred.

The Directive provides a checklist of emergency responses which would be required in the event of an earthquake, and, through Office of Emergency Operations review, assignment of responsibilities. However, although certain aspects of emergency response operations can be predicted (e.g. care centers, transportation routes), actual emergency response actions would not be determined until after an earthquake, when damages have been evaluated.

c. Association of Bay Area Governments

Since February 1979, ABAG has been developing a series of computer-based map files to provide basic areal data related to earthquake hazards. The following basic data are available for the Bay region:

Geology
Faults
Tsunami Inundation Areas
Dam Failure Inundation Areas

The basic data maps have been combined to create hazard map files. The following hazard map files are available:

Maximum Ground Shaking Intensity
Risk of Ground Shaking Intensity
Liquefaction Susceptibility
Fault Surface Rupture
Tsunami Hazard Areas
Dam Failure Hazard Areas

These are generalized maps which can be used for preliminary identification of potential geologic hazards.

B. Wildland and Structural Fire Hazard

1. Criteria

a. State and Regional Criteria

Wildland fire hazards of potential statewide critical concern include all those areas which have a classification of "extreme." These areas encompass wildlands which have high frequency rates of critical fire weather and "medium" or "heavy" fuel loading, or areas which have "medium" frequency fire weather and "heavy" fuel loading on slopes in excess of 40 percent.

(No regional criteria)

b. County of Alameda Criteria

Of significant County concern are:

- Areas with potential for especially destructive wildland fires;
- High occupancy uses, and industrial facilities which produce or store highly flammable or toxic materials.

2. Identification of Hazards

a. Structural/Urban Fire Hazards

The danger of extensive fire damage throughout all developed areas of the County is greatest in the event of a major earthquake, when there is the possibility that gas and water lines may be ruptured and access of emergency vehicles to certain areas restricted by damage to roads and bridges.

Urban development which presents the greatest fire hazard and threat to life and property includes high occupancy structures, densely developed areas, and some industrial uses. Industrial facilities which present the greatest fire hazard include those plants which produce or store highly flammable or toxic materials. Fire, explosions or spillages could threaten adjacent properties and require evacuation of surrounding populations. Similar hazards are associated with the transport by rail and highway of highly flammable, explosive or toxic materials.

Suburban and rural residential areas with relatively high potentials for structural fire damage include those lacking adequate water supply and fire hydrants and/or those in remote areas distant from fire stations. Most of these rural and very low density residential areas were developed before fire protection requirements were prescribed by ordinance. They may also be small clusters of residences exempted from subdivision ordinance requirements.

Many of these same rural areas also are subject to higher emergency response times due to the steep terrain winding and indirect roads, and longer distances from fire stations. Rates of severe structural damage are therefore relatively higher than in urban residential areas.

The Palomares Canyon and Kilkare Canyon areas are primary examples given existing levels of development, limited access, steep slopes, limited water supplies, dense vegetation and older homes.

Developed areas of significant concern include a limited number of hill areas which are more densely developed, or which are undergoing development. Much of the Berkeley and Oakland hill areas present a severe fire hazard and threat to life and property due to the density of residential development, proximity of residences to densely vegetated slopes, steep and rugged terrain, thick vegetation which often surrounds wood residences, and, in some areas, poor access for emergency vehicles.

b. Wildland Fire Hazards

The potential for destructive wildland fires is relatively high throughout the County's undeveloped hill areas due to the rolling to rugged terrain, continuous flammable vegetation cover, and long and dry summers with high wind conditions.

. Factors Affecting Wildfire Behavior

The combination of highly flammable vegetation, long and dry summers, and rugged topography give much of the County's wildland areas serious wildland fire potential. A system developed by the State Department of Forestry measures the relative fire hazard severity of wildlands based primarily on those conditions which most significantly contribute to the potential occurrence of high intensity fires. These factors include fuel (vegetation, structures), weather, and topography:

1) Fuel: The quantity of flammable vegetation, it's moisture content and arrangement, the ratio of dead material to living vegetation, and its chemical content all affect how a wildfire burns. Three vegetative types which are used to identify fuel loading for classifying fire hazard are: woods-brushland, scrub, and open. "Woods-brushland" is considered a heavy fuel loading; "scrub" is categorized as medium; and "open" is considered a light fuel loading.

2) Weather: Elements of weather that have significant effects on fire behavior are wind speed, relative humidity, and precipitation. Wind is the most critical weather factor because as wind increases in velocity, the rate of fire spread also increases. The drier the air the drier the vegetation and hence the more likely the vegetation will ignite and burn. Precipitation affects moisture content of dead and living vegetation which affects fire ignition and rate of spread. Fire weather is sampled daily at Department of Forestry stations and averaged to indicate "Fire Danger Rating Areas." Critical fire weather conditions indicating a high probability for high intensity fires are measured by the daily "Fire Load Index (FLI)," which combines the probable occurrence of a fire and its probable rate of spread and intensity. Three critical "Fire Weather Frequency Classes" Rating I, II, and III - in ascending order of severity, are used in the classification system to rate weather conditions.

3) Topography: Topography affects rate of fire spread. In general, fires burn more rapidly upslope than downslope. The steeper the slope, the faster the rate of fire spread. Topography also affects wind speeds and directions, and hence also affects the direction as well as rate of fire spread. Slope is a measurable criterion for classifying fire hazards due to these effects on fire spread, and also because of the varying degrees of difficulty terrain presents to fire suppression operations: in steeper, more rugged terrain travel times increase, the capabilities of mechanized equipment decrease requiring slower and more indirect methods of fire fighting.

Table 7 illustrates the methodology to be used to develop the Wildland Fire Hazard and Severity Map for Alameda County.

The California Department of Forestry (CDF) is now undertaking the zoning of all State Responsibility Land according to fire hazard severity, as required by Public Resources Code, Section 4291.5. CDF expects to complete the mapping project by January, 1983.

3. Provision of Fire Protection Services

a. Fire Protection Agencies and Responsibilities

Fire protection in Alameda County is provided by a number of public and private agencies. (See Table 8) Many provide structural and wildland fire protection services. Generally, structural fire protection is provided by city fire departments to incorporated areas, and by fire protection districts to unincorporated urban areas. Wildland fire protection is provided by East Bay Regional Park District, the County Fire Patrol and the California Department of Forestry. Several large regional, State, Federal and private facilities have their own on-site fire protection units (the latter will not be discussed in detail).

1) County Service Areas and Fire Protection Districts

Fire protection services in the unincorporated urban communities and rural areas are provided by fire protection

Table 7

FIRE HAZARD SEVERITY SCALE *

CRITICAL FIRE WEATHER FREQUENCY	I (1)			II [illegible]			III [illegible]		
FUEL LOADING	SLOPE %			SLOPE %			SLOPE %		
	0-40 (1)	41-60 (1.6)	61+ (2.0)	0-40 (1)	41-60 (1.6)	61+ (2.0)	0-40 (1)	41-60 (1.6)	[illegible]
Light (Grass) (1)	1	[illegible]	[illegible]	2	3.2	4	8	12.8	[illegible]
Medium (Scrub) (8)	8	12.8	16	16	25.6	32	64	[illegible]	[illegible]
Heavy (Woods-Brushwood) (16)	16	25.6	32	32	51.2	64	124	[illegible]	[illegible]

1-12.8	MODERATE HAZARD	16-32	HIGH HAZARD	[illegible] 256	EXTREME HAZARD

* Severity Factor Values are shown in Parentheses in the Table

a. Enter the Fire Hazard Severity Scale on the line of the proper Fuel Loading Class.
b. Move laterally along the Scale into the block below the appropriate Critical Fire Weather Frequency Class.
c. Move to the proper Slope Class and read the corresponding Fire Hazard Severity in accordance with the legend.
d. Example:
   1) The following determinations have been made for a 20 acre area:
      . . Fuel loading is 70 percent "scrub" and 30 percent "open"
      . . Critical Fire Weather Frequency Class is "III"
      . . Slope is "50%"
   2) Enter the Scale opposite the "Scrub" Fire Loading Class. Move laterally to Critical Fire Weather Frequency Class "III". In the 91-60 percent slope column, the Fire Hazard Severity Scale shows the area in question should be classed as "Extreme Hazard."

Source: Fire Safe Guides for Residential Development in California, California Department of Forestry.

districts or through the use of County Service areas. There are six fire protection districts (as listed on Table 8): Eden Consolidated, Castro Valley, Fairview, Tennyson, Redwood Canyon and Dublin-San Ramon. Six County Service Areas (CSA's) organized to fund fire protection service, contract with adjacent jurisdictions or with the County (Fire Patrol); properties in the CSA's are assessed for service costs. Five of the County Service Areas are located near the City of Pleasanton; of these, four contract with the City and the fifth is served by County and the State Department of Forestry. The sixth fire protection CSA, San Lorenzo, contracts with Eden Consolidated Fire Protection Districts.

The major districts and agencies are shown on Figure 7.

The following briefly describes the jurisdiction of these six fire protection districts:

a) Eden Consolidated Fire Protection District

The District serves the communities of Ashland, Cherryland and San Lorenzo.

The District was established in July 1976 combining the San Lorenzo Homeowners' Association (a County Service Area) and the Ashland and Cherryland Fire Protection Districts. The total area within the consolidated district is 8.0 square miles. Prior to the consolidation the departments used volunteers to assist paid staff. Currently the District operates three fire stations with a total of 54 personnel and 6 engines. The maximum response time is 3 minutes. Funding for the district prior to Proposition 13 was from property taxes from the district. The first year after Proposition 13 the difference was made up by funding from State surplus. The second year the State gave the Board of Supervisors augmentation funds for special districts. That is the current status of special districts.

None of the engines are equipped with pumps, although there are fire hydrants distributed throughout the District.

The District's fire prevention program includes weed abatement, building inspection, and educational services.

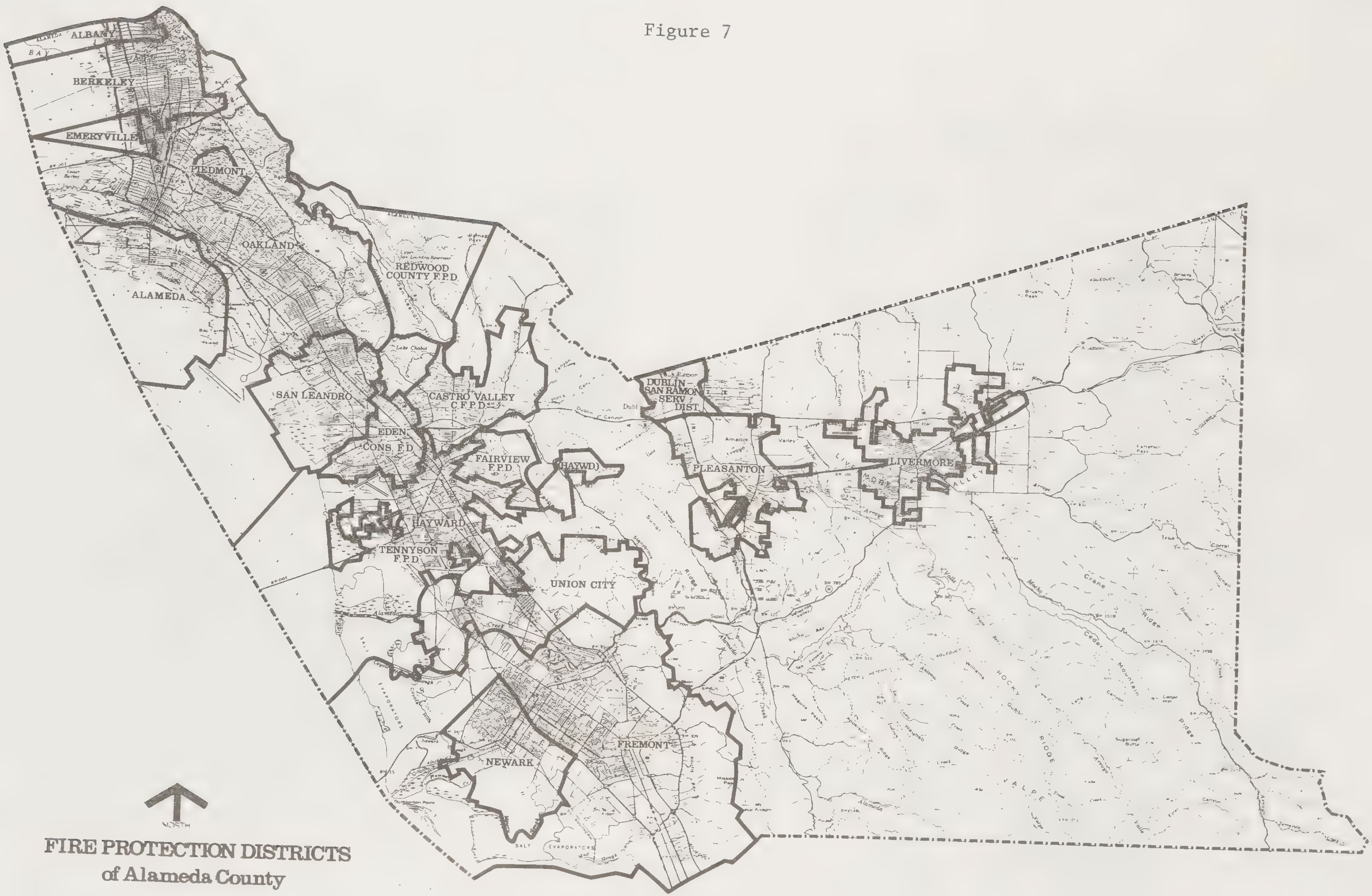
b) Castro Valley Fire Protection District

The Castro Valley Fire Protection District provides fire protection services to the unincorporated community

Table 8

Alameda County Fire Service Areas

	AGENCY	JURISDICTION
Municipal Fire Departments	Alameda Albany Berkeley Emeryville Fremont Hayward Livermore Newark Oakland Piedmont Pleasanton San Leandro Union City	INCORPORATED AREA (Pleasanton also includes 4 County Service Areas)
Fire Protection Districts	Eden Consolidated Fire District	San Lorenzo, Ashland, Cherryland.
	Castro Valley County Fire Protection District	Castro Valley area.
	Fairview Fire Protection District	County area northeast side of Hayward.
	Tennyson Fire Protection District	Portion of Hayward unincorporated area.
	Redwood County Fire Protection District	Northwest corner of Eden Planning Unit.
	Dublin-San Ramon Fire Protection District	Dublin-San Ramon area
Regional and State Fire Agencies	California Division of Forestry	Palomares Canyon, Sunol, rural areas outside city limits and fire districts.
	East Bay Regional Parks	Parklands
	Lawrence Livermore National Lab	Individual Sites
	Lawrence Berkeley National Lab	Individual Sites
	California Air National Guard	Individual Sites
Federal Fire Agencies	Camp Parks Air Force Base	Individual Sites
	V.A. Hospital	Individual Sites
	U.S. Naval Air Station	Individual Sites
	Navy Regional Medical Center	Individual Sites
	Navy Supply Center	Individual Sites
	Oakland Army Base	Individual Sites
	U.S. Coast Guard Training Center	Individual Sites
Private Fire Agencies	General Electric Corporation	Individual Property
	Palomares Area Land-owner's Association	Individual Property
	Sandia Corporation	Individual Property
County Fire Agencies	County Fire Patrol	Unincorporated areas of Murray Township
	OES Volunteer Fire Department	County Site
	Santa Rita Rehabilitation Center	County Site
	Fairmont Hospital Fire Department	County Site



FIRE PROTECTION DISTRICTS of Alameda County

Note: Areas not in City or Special District Service Areas are served by the California Division of Forestry and/or the Alameda County Fire Patrol.

of Castro Valley. Formed in 1927, the Castro Valley Fire Protection District serves an area of approximately 12.5 square miles. The District operates three fire stations in Castro Valley and has 51 employees. An additional fire station is planned to be built to serve the Jensen Ranch Development, just east of Castro Valley. Equipment includes 3 pumper engines, one aerial ladder truck, one four-wheel drive grass rig, and a reserve rig. Response time is 2-3 minutes to most of the community.

In the Canyon area, depending on traffic conditions, responses may take about 1-2 minutes longer.

Water supply for fire protection is good, except in the Canyon areas where pumpers must be used. Funding of the District is from property taxes, funding from State surplus and State augmentation funds.

The Districts' fire prevention program includes weed abatement, building inspection and educational outreach to schools and service groups.

Over the last 3 years the number of calls for fires and medical emergencies has increased. Part of this increase is attributed to the aging of structures and to an increase in the service area population.

c) Fairview Fire Protection District

The Fairview Fire Protection District, formed in 1938, has a 4.0 square mile service area in the unincorporated area east of Hayward and south of Castro Valley. The District encompasses large wildland and rural areas (The Don Castro Regional Recreational Area) as well as urban residential and commercial areas. Fairview is an autonomous district governed by a Board of 5 members.

The District has one station centrally located within the service area and has an average response time of 2 to 3 minutes. The more distant, inaccessible points within the service area may require a 5-minute response time. The District operates two 1250 gpm (gallons per minute) engines, one 400 gpm engine and one 4-wheel drive grass fire truck. Funding is through a district property tax and supplemented by funds from State surplus and augmentation funds.

The District has a full-time fire fighting force of 8 and a volunteer force of 21. The water supply is adequate throughout most of the District; more than half the area has water pressure of 1,000 gpm. However, the pressure, in portions of the hill area served by the District, is as low as 500 gpm. To date, this has not been a problem.

There have been no staff cutbacks, to date, as a result of Proposition 13. However, Fairview Fire Protection District staff had included 6 CETA workers; these positions have been eliminated. Further, there have been no improvements in capital equipment.

As the Fairview Area has become increasingly urbanized, there has been an increased number of call-responses made by the District and, also, a gradual shift in the type of services provided. Alarm data show that the number of calls have been increasing and that while grass fire calls have declined, medical assistance calls are of increasing relative importance.

d) Tennyson Fire Protection District

The Tennyson Fire Protection District was established in 1947 to serve a small unincorporated pocket in the southern portion of Hayward.

The Department is staffed with 12 volunteers. The District maintains one station. Equipment includes two trucks, one 500 gallon engine and one 1250 gallon tanker. There are no fire hydrants in the Tennyson district, so all water must be brought to the fire. The average response time is 3-4 minutes. The City of Hayward will provide back-up assistance should there be a shortage of volunteers. The District is funded by federal funds and local property taxes.

The District has implemented a weed abatement program that has reduced grass fires to a minimum.

e) Redwood County Fire Protection District

The Redwood Fire Protection District encompasses an 18.75 square mile area in the northwest corner of the Eden Planning Unit. Structural and wildland protection is provided through contract with the East Bay Regional Park District. Most of the land area of the district is either Regional Parklands or East Bay Municipal Utility District watershed lands. Privately owned lands include a small group of residences immediately adjacent to Oakland and a few homes in Cull Canyon. A station is located at Cull Canyon to provide structural protection. Funding for the district is provided by County taxes, funding from State surplus and State augmentation funds.

There are no hydrants in the District. Water must be carried or wells, water tanks, and swimming pools utilized.

f) Dublin-San Ramon Service District

The Dublin-San Ramon Service District provides structural and wildland fire protection services to the Dublin area in Alameda County and to a portion of San Ramon and Contra Costa County. The fire protection unit employs 31 full-time firefighters and is supplemented by 12 volunteer firefighters. The District has two fire stations. Equipment includes two 1250 gpm pumpers, two 1000 gpm pumpers, one 125 gpm grass fire truck, one 150 gpm attack pumper, a rescue truck, 2 pick-up trucks and a chief's car. This District funding is provided by property taxes.

The average response time in the District is 3-3½ minutes.

The District participates in an educational program, weed abatement and maintenance of fire breaking. There is also a cardio-pulmonary resuscitation program in cooperation with Valley Memorial Hospital.

2. Wildland Fire Protection Agencies

a) East Bay Regional Park District

The EBRPD's fire fighting unit is responsible for fire suppression on park lands and on some public and private property through mutual assistance agreements and contracts in Alameda and Contra Costa Counties. The staff includes one captain and four firefighters. The 55 park maintenance workers also serve as firefighters, as required. The unit has available a total of 40 vehicles including four-wheel-drive, tanker, and structural fire protection vehicles; two administrative cars; and one rescue vehicle. In addition to this, the District has three helicopters to fight wildfires in areas inaccessible to trucks.

This equipment is distributed among five park areas: Tilden Park, Redwood Regional Park, Garin Regional Park, Sunol Regional Wilderness and Del Valle Regional Park.

Response time varies from 3 to 45 minutes. In most cases, water must be carried to the site of the fire.

Between 1974 and 1977, the number of emergency responses increased. Since 1977 there has been a decrease. Part of the 1974-77 increase is attributed to increased park usage during that period. However, weather conditions (drought conditions, winds, etc.) are the major factor affecting the incidence of wildland fires within the parklands. However, recent financial constraints have required the curtailment of major capital purchases, although staffing has not been reduced.

b) County Fire Forces

The Alameda County Board of Supervisors is ultimately responsible for fire protection services to all areas that are not served by a city, Fire Protection District or through a CSA. The Assistant Director of OES, a division of the Sheriff's Department, serves as the County Fire Warden. Service in the Livermore Valley is provided by two agencies; Fire Patrol (eastern half) and CDF (western half) through contract with the County. The four agencies under the responsibility of the County are as follows:

- Fire Patrol: Provides structural and wildland fire protection from its station in Livermore to portions of Murray Township outside the City of Livermore. Equipment includes two off-the-road vehicles, a 300 gallon tanker truck, a 1000 gallon tanker and a chief's car. There are a total of 13 firefighters with three to four per shift. Due to the remoteness of much of the area from the single station, response time can be up to 25-30 minutes.

  One-half of the funding is provided by the County Structural Fire Fund, matched by supplemental wildland protection funds.

  Mutual aide back-up is provided by the Sunol Station of CDF. There is also some assistance from OES County volunteers and the Lawrence Livermore National Lab station.

  The Fire Patrol is empowered to enforce the state clearance and fire prevention laws, including weed abatement and building inspections.

- Santa Rita Rehabilitation Center Fire Department (Sheriff-Fire Warden). Protection to the facilities of the Center and other county-owned buildings. The Department is staffed by one paid Chief and inmate fire fighters augmented by Deputy Sheriffs.

- Auxiliary Fire Service. Administered through the Office of Emergency Services (Sheriff-Director of the Office of Emergency Services

- Fire Warden). The auxiliary Fire Service provides a trained pool of people for mutual aid purposes and augments County fire forces. The service is equipped with three trucks. Of this, one off-road vehicle and one regular fire truck are stationed at the County Livermore station.

- Fairmont Hospital Fire Department (Sheriff-Fire Warden). Provides protection to County facilities located in the Fairmont Hospital area. The unit has one engine, three paid firefighters, and up to 15 volunteer personnel drawn from County employees.

c) California Division of Forestry (CDF)

The CDF is responsible for fire prevention and suppression in the watershed or wildland areas, their "state responsibility area." Protection against structural and wildland fire hazards is also provided to unincorporated parts of the County by contract. These contract areas are commonly referred to as the "local responsibility area."

The Sunol Schedule A operation provides structural and supplemental wildland fire protection to unincorporated areas in the Pleasanton, Eden, and Washington Townships year-round. The Schedule A operation is a portion of Sunol Station operation provided under contract to Alameda County. This contract provides one engine with a minimum staffing of two personnel.

The Sunol Schedule B, or State operation, provides wildland fire protection as required by statute to all State Responsibility lands in Alameda County during the declared fire season. This operation consists of a Chief Officer, two engines with an average of three personnel on duty per engine, and one fire control bulldozer with one person on duty. Also, during the declared fire season, the Alameda County fire forces are augmented by all of Santa Clara Ranger Unit's equipment, which includes 19 engines, 4 fire control bulldozers, 1 helicopter, and 5 Chief Officers.

Immediate augmentation is provided by the Sunshine Station located in Contra Costa County on Marsh Creek Road, five miles north of the County line. Its effective area of response is the Altamont-Mountain House area of northeastern Alameda County. Sunshine is a two-engine station with an average three personnel per engine.

The Castle Rock Station is one and one-half miles east of the County line on Corral Hollow Road in San Joaquin County. Its effective area of response is Mountain House, Altamont, Tesla, Corral Hollow, and the northern portion of Mines Road in Alameda County. The Castle Rock Station has one engine with an average three personnel on duty.

The San Antone Station in Santa Clara County is approximately three miles south of the County line on Mines Road. San Antone is a one-engine station with an average three personnel on duty. Its effective area of response is the southern portion of Pleasanton and Murray Townships.

The Sunol Ranger District's Fire Prevention Plan outlines the activities of the Sunol, Castle Rock, and Sunshine Stations. The District enforces the clearance laws (PRC Section 4291), and structures may be inspected as many as four times for vegetation clearance and chimney screens. Ranger Stations issue controlled burning permits in cooperation with the BAAQMD and inspect machines used in natural areas for spark arrestors and power lines and landfill sites before and during the fire season (usually May to October). Rangers patrol areas with high risk created by motorcycles, fireworks, or campfires. The Sunol Ranger District emphasizes fire prevention and displays roadside fire danger signs to inform the public of the degree of fire hazard on any day during the fire season, based on daily climatic conditions.

b. Insurance Rating

A measure of the level of fire protection within fire protection districts is the Fire Insurance Class Rating, assigned by the Insurance Service Office for insurance cost purposes. Current ratings for the several fire protection service areas are summarized in Table 9. Ratings are based on such factors as fire department response times, local water supply, and the presence or absence of fire hydrants. Of these, a public water supply system and fire hydrants are the most critical in setting insurance rates.

c. Fire Protection for New Development

For new development in unincorporated areas there are a number of alternative arrangements for providing fire protection services, including:

- incorporate as a city
- annex to the adjacent city
- establish a County Service Area or homeowners association
- establish an independent Fire Protection District
- contract with another agency (City, County, Fire Protection District, etc.)

TABLE 9

Fire Insurance Class Rating

AGENCY	CLASS RATED 1/
City Fire Departments	
Alameda	3
Albany	3
Berkeley	2
Emeryville	4
Fremont	4/9
Hayward	3/9
Livermore	4
Newark	4/9
Oakland	NR 2
Piedmont	3
Pleasanton	4/9
San Leandro	3
Union City	5/9
Dublin-San Ramon County Service District	3
Eden Consolidated Fire District	4
Castro Valley County Fire Protection District	4/9
Fairview Fire Protection District	4
Tennyson Fire Protection District	10
Redwood County Fire Protection District	10
Alameda County Fire Patrol	8/9
California Department of Forestry	10

1/ X/9 - 9 is designated to an area over 1,000 feet from a fire hydrant.
10 - the area is unprotected

2/ NR 2 - Oakland is "not rated" - it is its own statistical area. Each year it is rerated based on experience.

Source: Insurance Service Office, May, 1981

The selection of a service provider arrangement is based on factors unique to the new development. Nevertheless, in many developments a fire station and water supply will have to be established. The County is currently not equipped to provide services to a medium to large scale urban development.

4. Mitigation of Fire Hazards

To mitigate fire hazards in the County, coordinated with the fire protection and prevention programs implemented by the individual fire protection agencies are ordinances, standards, emergency operations plan, a mutual aid plan and a medical emergency program. This section will address these latter issues.

a. Structural Fire Protection Ordinances & Standards

1) County-wide

The Uniform Fire Code, together with the Uniform Building Code, form the basis for the local structural fire protection standards. Alameda County is currently updating its Building Fire Codes to the 1979 Editions. Table 10 shows which codes are used by the cities in the County.

Building inspection divisions of the local governments regulate building construction. Inspections cover the general field of structural safeguards, including fire hazards and electrical wiring, consistent with code standards. The Uniform Building Code governs provisions relating to minimum standards for the regulation and control of the design, construction, quality of materials, use, occupancy, and location of buildings. The Uniform Fire Code governs the maintenance of buildings and premises by regulating the storage, use, and handling of dangerous and hazardous materials, substances, and processes, and by regulating and maintaining adequate egress facilities. It provides for the installation and maintenance of fire protection systems and appliances under the direction of the local chief. Fire appliances in other than private dwellings, the location of hydrants, and the required water system fire flow are designated by the Fire Chief. The District Chiefs' standards are to be consistent with the Fire Code and the Insurance Services Office's standards.

2) Alameda County - Unincorporated

a) Health and Safety Ordinance

Alameda County's Health and Safety Ordinance prescribes standards for the storage and handling of cellulose nitrate film and cellulose nitrate plastics, chemicals and explosives, flammable liquids and gasses, lumber, and matches. It also prescribes general precautions against fire relating to combustible material, hay, straw, weeds, litter, balloons

TABLE 10

Building Codes for the Cities in Alameda County

CITY	UNFORM BUILDING CODE	UNIFORM FIRE CODE	COMMENTS
Alameda	1979	1979	
Albany	1976	1976	In the process of updating to 1979
Berkeley	1979	1979	
Emeryville	1979	1979	
Fremont	1979	1976	Fire Code will not be updated to 1979 UFC
Hayward	1976	1976	In process of updating to 1979
Livermore	1979	1979	
Newark	1976	1979	
Oakland	1979	1976	Fire Code will not be updated to 1979 UFC
Piedmont	1979	N/A	Writing their own Fire Code
Pleasanton	1979	1979	
San Leandro	1979	1979	
Union City	1973	1973	Under study to update to 1979
Unincorporated Alameda County	1979	1979	

with flammable gas, flammable decorative materials in stores, lighted candles, and self-service gas stations.

b) Subdivision Ordinance

The County Subdivision Ordinance requires that, in a fire protection district, the subdivider or developer must install water mains, fire hydrants, gated connections, and appurtenances to supply water for fire protection in conformance with district standards.

c) Water Supply Standards

Water supply standards for fire protection--fire flow, size of distribution mains, hydrant spacing--are established by the Insurance Services Office in their Grading Schedule for Municipal Fire Protection. The water supply must be capable of delivering a minimum of 500 gallons per minute for one hour. This is the minimum fire flow required in Alameda County. Required fire flow[1] is the rate of flow needed for fire fighting purposes to confine a major fire to the buildings within a block or other group complex; and the determination of this flow depends upon the size, construction, occupancy, and exposure of buildings within and surrounding the block or group complex. Water mains are to be at least 6 inches in size for residential areas and at least 8 inches in commercial districts. The distribution of hydrants is based upon the required fire flow. Where the required fire flow is 1,000 gallons per minute or less, the average area served by each hydrant is 160,000 square feet.

d) Road & Design Standards

Road construction and maintenance standards are necessary in order to provide for adequate access for fire and emergency vehicles and for routes of escape to accommodate evacuations. While the County has not published minimum roadway design criteria, it has developed some standards and policies for the following: ingress-egress routes, right-of-way width, street grades, minimum centerline radius of curvature, and vegetation clearance.

Official County Policy on the design and improvements required of Residential Planned Development

[1] Insurance Service Office, Grading Schedule for Municipal Fire Protection (1973) p. 11.

does not specifically prescribe fire protection standards and principles, but it does require safety features which would provide for fire protection to residential dwellings. A building site design principle recommends that "dwelling units should be situated in locations which are not subject to the probability of natural or man-made dangers, annoyances, or inconveniences." Building site design standards require a minimum five-foot yard adjacent to each exterior building wall, and this may be increased depending on the height and building wall length. Design principles and standards for access ways include the consideration of accommodating large service and emergency vehicles (travel lane width, grades, horizontal curves).

b. Wildland Fire Protection Ordinance & Standards

. <u>California Public Resources Code</u>

Specific standards for wildland fire prevention are prescribed in the Public Resources Code and are enforced by the State Department of Forestry. The Sunol Ranger District, the East Bay Regional Park District, and the County Fire Patrol in Livermore are responsible for wildland fire prevention and protection in Alameda County.

The State Fire Laws as expressed in the Public Resources Code pertain to permits for burning and blasting, fire hazard reduction, spark arresters, penalties, and liabilities. Standards for fire hazard reduction in wildland areas include the State Forest and Fire Law Clearance Requirements; firebreaks of not less than 30 feet around structures and dumps, trimming of trees and combustible vegetation within 30 to 100 feet of a structure, maintenance of the roof of any structure to be free of dead vegetation, screens over chimney outlets, maintenance of power lines, and spark arresters for motorcycles.

c. Emergency Operations

The Alameda County Emergency Operations Plan includes sections on Fire Services and Rescue Service. The Emergency Operations Plan applies fully to the unincorporated area and to the contract cities of Berkeley, Emeryville, Hayward, Newark, Piedmont, Pleasanton, San Leandro and Union City. Albany, Alameda, Fremont, Livermore and Oakland have developed their own emergency plans.

The Fire Marshall and Fire Protection Agencies are responsible for implementation. The section sets forth the organizational relationship of fire protection services; the role of these agencies in the event of a natural disaster or state of war; mutual aid; available resources and supporting systems. A key is the mutual aid plan.

d. Mutual Aid

Each agency participates in the County Mutual Aid Program, administered through the County Office of Emergency Services (OES). Each participating agency may, as required, request assistance from other jurisdictions designated by OES. A similar mutual aid program is in effect for the Bay Area. The statewide mutual aid program is administered by the State Office of Emergency Services.

e. Medical Emergencies

Among the services provided by the fire departments is response to medical emergencies. About five years ago, the County received a federal grant to upgrade emergency services (including ambulance and hospitals) and implement a program in which all calls are received through 911 and for all Code 3 calls(emergency with sirens) the nearest fire department also responds. The fire departments do not have para-medic staff and equipment; however, a number of the firefighters have Emergency Medical Training (EMT). For the County agencies, approximately 60% of the calls are currently medical emergency.

C. Flood Hazards

1. Criteria

a. State and Regional Criteria

Flood prone areas of potential statewide critical concern include areas which have a one in one-hundred chance on the average of being inundated any year. Of critical regional concern are those lands within this 100 year flood plain, as well as areas subject to inundation through dam failure, and areas subject to inundation through dike and levee failure.

Tsunamis: Areas that have experienced recurrent damaging seismic sea waves in historic times.

b. County of Alameda Criteria

Areas of significant County concern include:

1) Areas within the 100 year flood plain.

2) Areas subject to inundation through dam failure or subject to inundation through dike or levee failure.

3) Areas where the alteration of drainage patterns and rates may result in inundation of downstream development.

Tsunami and Seiches: Areas which could be inundated by a tsunami with a recurrence frequency of once in 200 years. Areas subject to inundation from a seiche in San Francisco Bay or within dams and reservoirs within or upstream from the planning area.

2. Identification of Flood Hazards

A flood hazard area is one in which surface waters inundate normally dry land areas causing damage to property and/or creating conditions which are hazardous to life and health. While flooding is primarily a natural process, man-made developments can affect the severity and frequency of a flood. Flood hazards are here divided into three general categories:

1) Flooding, resulting from dam and/or reservoir failure;

2) Flooding resulting from runoff of rain and snow-melt water from upstream watersheds or from runoff in local areas; and

3) Flooding caused by tsunamis (seismic sea waves) or by seiches.

This section reviews flood control and management, agency responsibilities, dam inundation, tsunamis hazards and seiches.

a. Flood Control and Management

Flood losses may be reduced through structural and nonstructural measures. Structural measures include flood-water storage systems, such as dams, reservoirs, and basins, and related facilities, such as levees and channels. Nonstructural measures include flood forecasting; zoning; subdivision and building code regulations; educational programs; and flood insurance programs.

Throughout the urbanized parts of the County, flood hazards have been largely eliminated through flood control projects. Most drainage systems are adequate to carry runoff from a ten-year storm, and many from a twenty-five year storm. With larger storms, general flooding could occur but primarily as sheet flow in streets and along stream channels.

In response to requirements of the Flood Disaster Insurance Act of 1973, flood hazard maps have been prepared by the Federal Emergency Management Agency indicating the extent of the floodways (channel of stream and portion of a flood plain required to carry flood flows without significantly raising the level of flood waters) and flood fringe (portions of flood plain outside the floodway) of streams associated with a 100 year flood. These maps were updated in April 1981.

Extensive flooding could result due to an earthquake. Effects include inundation caused by dam failures both within and upstream from the planning area, overtopping of reservoirs caused by seiches or bank failures, and damage to creeks and earthen flood control channel banks. Major dams in and upstream from the planning area have been evaluated by the State Division of Safety of Dams, which has imposed requirements that, where necessary, these facilities be made earthquake resistant.

b. Agency Responsibilities

County Flood Control and Water Conservation District

Flood Control and Water Conservation District (ACFCWCD) is responsible for the control of flood and storm waters within the County. The District is subdivided into ten Flood Control zones for financing of flood control improvements. (See Figure 8)

All District zones are the responsibility ultimately of the Board of Supervisors. Zone 7, which includes the Livermore-Amador Valley and surrounding hills in the east County, has a separately elected Board of Directors with responsibility for the Valley area. The cities of Alameda, Albany, Berkeley, and Piedmont are not currently in a Flood Control zone, although each city has its own flood management program.

Office of Emergency Services

The County Office of Emergency Services is responsible for flood emergency plans and precedures and for the Dam Failure and Evacuation Plan.

c. Dam Inundation

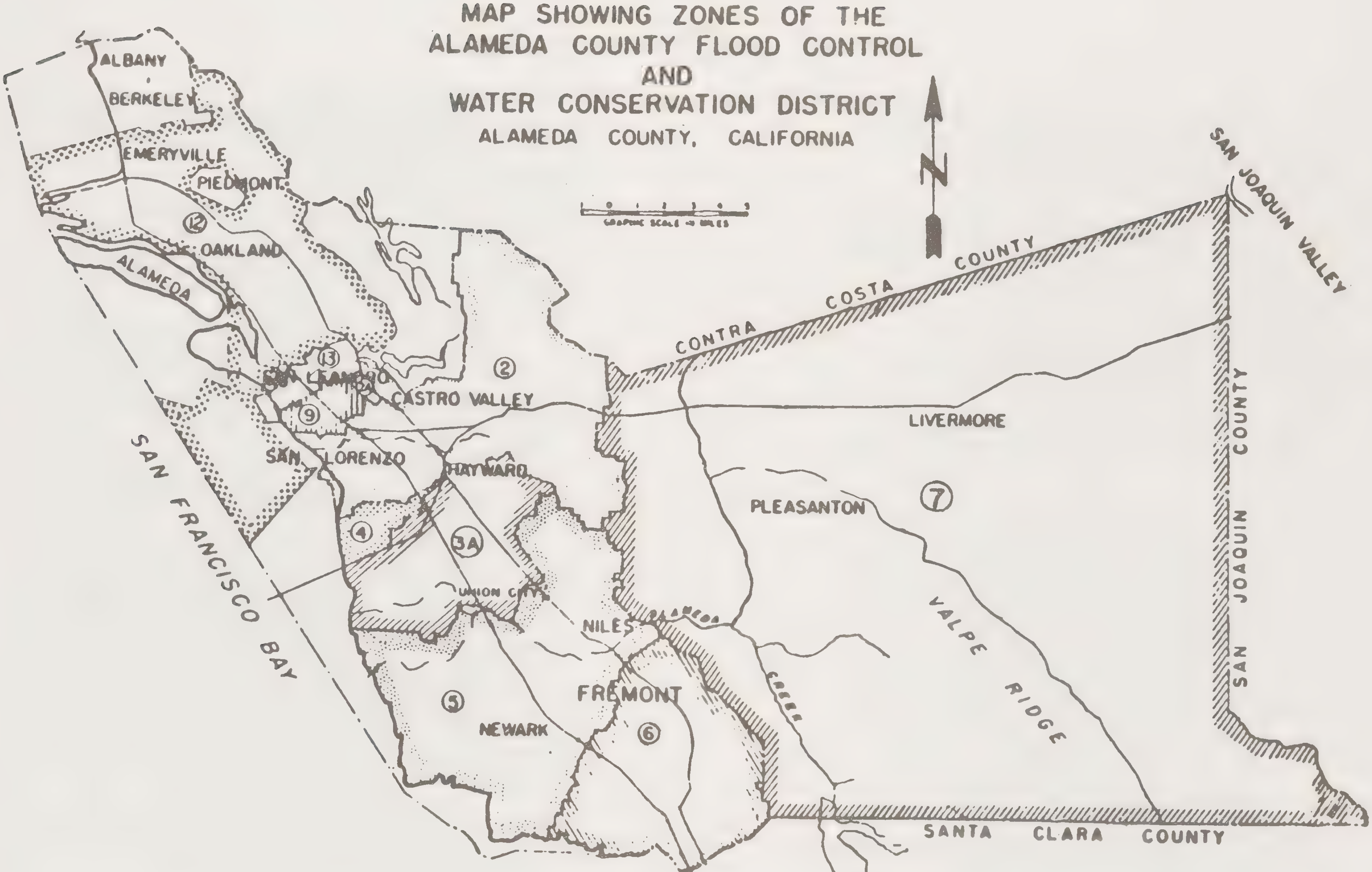
There are 29 dams in Alameda County. These impound about 291,000 acre feet of water, of which 92% is contained by the four largest dams: Calaveras (100,000 acre feet), Del Valle (77,100 acre feet), James H. Turner (50,500 acre feet), and Upper San Leandro (41,436 acre feet).

For each of the 29 dams in Alameda County, the owner, capacity in acre feet, jurisdictions involved and the estimated resident population in the inundation area are presented on Table 11.

Failure of Calaveras Reservoir, located on Calaveras Creek in the Diablo Mountain Range, would result in the flooding of a portion of Sunol Valley; Newark; Union City; Hayward and Fremont.

The Del Valle Dam is located south of the City of Livermore. Its failure would result in the inundation of the Amador Valley; Sunol Valley; Niles Canyon; and extensive areas in the Cities of Pleasanton, Fremont, Newark, and Union City.

Figure 8



SOURCE: ACFCWCD, Report on Alameda County Flood Control and Water Conservation District Zone Programs, April 1977

TABLE II

Dams in Alameda County

NAME OF DAM	OWNER	CAPACITY ACRE/FEET	JURISDICTION INVOLVED	1970 POPULATION OF INUNDATION AREAS
Almond	EBMUD	20	C	1,200
Berryman	EBMUD	45	A,B	10,300 1/
Bethany Reservoir	CALIF	6,400	C	40
Calaveras	SF	100,000	C,F.H,N,UC	160,390
Central	EBMUD	485	O	7,664
Chabot	EBMUD	10,300	C,O,SL	62,317
Cull Creek	ACFCD	310	C,H	Less than 10
Del Valle	CALIF	77,100	C,L,PL,F H,N,UC	192,356
Dunsmuir	EBMUD	197	O,SL	8,040
Estates	EBMUD	56	O,P	1,490
James H. Turner	SF	50,500	C,F,N,H,UC	139,755
Lake Temescal	EBRPD	485	O,E	14,075
Lower Edwards	MT. VIEW	36	O	N/A
Patterson (1-62)	CALIF	98	C,L	1,050
Piedmont	EBMUD	60	O,P	2,077
San Lorenzo Creek	ACFCD	380	C,H	185
Seneca	EBMUD	92	O	1,160
South	EBMUD	156	C,H	2,012
Summit	EBMUD	117	A,B	657
Three J Ranch	LABORERS	56	C	2,360
Upper Edwards	MT. VIEW	30	O	N/A
Upper San Leandro	EBMUD	42,700	C,O,SL	82,950
Ward Creek	ACFCD	130	C,H	8,150
Dingee	EBMUD	13	O,P	421
Claremont	EBMUD	25	O,B	4,321
39th Avenue	EBMUD	31	O	1,840
Upper SL Clearwell No. 1	EBMUD	11	O	N/A
Upper SL Clearwell No. 2	EBMUD	20	O	N/A
San Pablo Clearwell	EBMUD	17	A	1,837

A - Albany
B - Berkeley
C - County
E - Emeryville
F - Fremont
H - Hayward
L - Livermore
N - Newark
O - Oakland
P - Piedmont
SL - San Leandro
UC - Union City
PL - Pleasanton

SF - City/County of San Francisco
ACFCD - Alameda County Flood Control District
EBMUD - East Bay Municipal Utility District
EBRPD - East Bay Regional Parks District
CALIF - State Department of Water Resources
MT. VIEW - Mt. View Cemetary Association
LABORERS - Laborers Pen Trust Fund for Northern California

1/ In Alameda County, additional in Contra Costa County

N/A Population has not been calculated with Oakland's jurisdiction.

SOURCE: Dam Failure and Evacuation Plan, Alameda County Office of Emergency Services, August 1981, and City of Oakland Police Department

The James H. Turner Dam, on the San Antonio Reservoir, is located east of Sunol Valley, Dam failure could flood the following areas: portion of Sunol Valley; Niles Canyon; a southwestern portion of the City of Hayward; and large areas in Fremont and Union City.

The Upper San Leandro Dam is located in the San Leandro hills. Its failure would flood southern Oakland and San Leandro.

The smaller dams in the County pose a less extensive safety hazard; however, several residential areas immediately downstream could be subject to sudden flooding and small bridges would be washed away. In some instances, flooding would primarily be confined to the flood control channel. (Discussed under Flood Plain Inundation)

d. Tsunamis Hazards

Tsunamis, or seismic sea waves, are long, water waves generated by sudden displacement under water. The most common cause of significant tsunamis is impulsive displacement along a submerged fault, associated with an earthquake.

The largest recorded tsunami affecting the California coast was in 1964, triggered by a major earthquake in Alaska. The highest coastal runup was in Crescent City. A 7-foot high wave was recorded at the Golden Gate and about 3-3/4 feet along the Richmond Shoreline. Studies by the U.S. Geological Survey (1972) predicts that San Francisco Bay will experience a 20 foot high tsunami at the Golden Gate at a frequency of every 200 years. This wave height would be reduced by half by the time it reaches the Albany/Berkeley shoreline and would decrease further at it travels south.

All cities in Alameda fronting on the Bay would be subject to some level of inundation from a tsunami. The most susceptable areas include Berkeley: all the waterfront plus a few blocks of industrial areas south of University Avenue; Emeryville: waterfront, residential, industrial and marina areas; Oakland: primarily the Oakland Army Base, U.S. Naval Supply Center and small portions of the Oakland Airport; Alameda: the coastal line generally exposed to the open Bay; and San Leandro: the waterfront, including the San Leandro Marina, the San Leandro Recreational Shoreline, the city's sewage treatment plan and the San Leandro Cable Television facility.

e. Seiches

A seiche is a long wave set up on an enclosed body of water such as a lake or reservoir. Seiches are inundations of the water surface that travel back and forth at regular periods determined by the depth and size of the water body. Seiches are usually caused by unusual tides, winds or currents, but may also be triggered by earthquake ground motion.

In the Bay Area there is insufficient historical or current data regarding the occurrence or impact of seiches during an earthquake. This does not imply that damaging seiches will not occur in the future, only that at present an accurate assessment of the hazard posed by seiches is not feasible.

3. Mitigation of Hazards

a. Dam Failure

1) State Requirements

Dam Failure may or may not be caused by an earthquake. However, the near-disastrous failure of the lower San Fernando Dam during the San Fernando earthquake of February 9, 1971, prompted the State Legislature to amend Section 8589.5 of the Government Code (SB 1362 in 1972) so as to require owners of all dams whose failure, according to the State Office of Emergency Services, would result in death or personal injury to prepare inundation maps showing the areas of potential flooding in the event of sudden or total failure of the facility. Mapping of areas of potential flooding assumes that:

1. Reservoirs would be filled to spillway height (maximum capacity) at the time of failure;

2. Dams would fail suddenly and completely rather than partially; and

3. Lands subject to inundation are water saturated prior to the dam failure.

The maps indicate the maximum area of potential flooding. However, they do not give an accurate description of maximum depths of the flood waters; this information would also be needed to evaluate the severity of the dam inundation hazard. However, depth information would have to be continually updated to include the affects of new developments.

2) Dam Inundation Maps and Plans

Inundation maps have been completed for 29 dams in the County. These were used by the County Office of Emergency Services in preparation of its Dam Failure and Evacuation Plan, adopted August 1977, and updated through August 1981. The Plan covers the unincorporated County and the cities of Berkeley, Piedmont, Hayward, Emeryville, San Leandro, Union City, Newark and Pleasanton. The OES also provides administrative services to those jurisdictions who are otherwise responsible for emergency service operations.

Fremont, Livermore, Alameda, Albany and Oakland do not currently contract with the County OES for emergency planning. All but Oakland have developed their own plans which have been approved by the State OES. Oakland is in the process of developing its own Dam Failure and Evacuation Plans.

The Dam Failure and Evacuation Plans includes inundation maps and evacuation plans for individual dams in the County. These plans also include information regarding:

1) The dam/reservoir owner, with emergency phone numbers;

2) Procedures for residents in inundation areas;

3) Estimated number of residents threatened;

4) Personnel evacuation assembly locations;

5) Transportation;

6) Traffic control;

7) Care for people, including location, capacity and facilities for mass care facilities.

8) Area security; and

9) Communication.

3) Dam Safety

Under the direction of the Water Resources Department, Safety of Dams Division, all dams are annually inspected based on current state of the art standards. A change in these standards may require special studies. For example, the failure of the lower San Fernando Dam, a hydraulic fill embankment in Southern California, during the San Fernando earthquake in 1971, prompted a re-evaluation of other hydraulic fill dams in the State.

An investigation of the Calaveras Dam in Alameda County was undertaken for the San Francisco Water Department to evaluate its structure and performance relative to its stability and safety. The evaluating consultant concluded that it is not likely that major abrupt surface fault offset will occur beneath the dam during its useful life, and under dynamic earthquake loading, complete or catastrophic liquefaction leading to a failure similar to the problem at the lower San Fernando Dam would not occur at the Calaveras Dam. But the consultant recommended that in order to prevent catastrophic damage by slumping and overtopping of the crest under dynamic loading from a nearby earthquake, the upstream and downstream slopes required some stabilization. These improvements were completed in 1975 and were approved by the State.

The Water Resources Department also undertook an inspection of 120 dams in high hazard areas of California, through contract with the U.S. Army Corps of Engineers under the National Dam Inspection Program. The Calaveras and Turner Dams, in Alameda County, were examined under this program and both were determined to be safe.

EBMUD, which owns 17 of the dams that could inundate portions of Alameda County, has developed a Dam Safety Analysis program providing for ongoing review of the safety of its facilities. The District currently has underway a study of its smaller dams: including Central Estates, Piedmont, Summit and Berryman. The study is not complete at this time.

Based on a prior study of EBMUD's larger dams, modifications were made at Upper San Leandro, Chabot and San Pablo reservoirs. Upper San Leandro was rebuilt in 1977; a new spillway was added to Chabot; and San Pablo was strengthened in 1980.

4) Emergency Procedure Preparedness

The County OES and the individual cities undertake periodic emergency drills involving County staff to prepare for all emergency situations, including dam failure and inundation. The County OES is currently developing a plan for emergency evacuation procedures which would be followed in all emergencies. In case of an inundation, the OES Plan includes provisions to advise affected residents of evacuation routes and emergency centers, However, there are no formal County or city public education/awareness programs providing general public information on preparedness for flood emergencies. The State of California OES is currently providing a video program to be aired on a major television network. The program will also be available for local education programs.

If a dam failure is the result of an earthquake, OES will check all mass care centers for structural safety before residents are informed that evacuation procedures are underway. However, care centers are generally school buildings, which are in conformance with the Field Act, or other public buildings.

b. Flood Plain Inundation

1) Nonstructural Programs

a) National Flood Insurance

The recognition of the severity of the flood hazard problem in the United States resulted in the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 which call for the identification of flood plain hazard areas and the adoption of land use control measures for flood hazard areas in order for communities to be eligible for participation in the National Flood Insurance Program.

The program allows property owners in participating communities to purchase flood insurance at federally subsidized rates; flood insurance at actuarial, non-subsidized rates is most often prohibitively expensive. The 1973 Act also requires federal agencies to disapprove any financial assistance for acquisition or construction in identified flood hazard areas of localities which fail to qualify. The federal insurance program defines a flood hazard area[1/] as one subject to inundation by a 100-year flood, which theoretically occurs once in 100 years or has a 1% chance of occurring in any given year.

Flood hazard maps for Alameda County were most recently updated by the Federal Emergency Management Agency (FEMA) in April 1981. The maps indicate the extent of floodway and flood fringe of waterways associated with a 100-year flood. The mapped waterways include: Alameda Creek, Crow Creek, San Lorenzo Creek, Palomares Creek, Arroyo Valle, Arroyo Mocho, Cottonwood Creek, Arroyo Las Positas, Tassajara Creek, Arroyo de la Laguna, Chabot Creek, Alameda Creek and Canal, Dublin Creek, Sinbad Creek, Arroyo Seco, and Altamont Creek.

b) County Ordinances

In March 1981, the County of Alameda's Building and Subdivision Ordinances were amended by the Board of Supervisors to bring them into compliance with National Flood Insurance Program requirements. The ordinance requires that structures built in flood hazard areas shall have the first floor above the 100-year flood elevation. The new provisions of the Building and Subdivision Ordinances are generally intended to assure flood protection to development on a flood plain. Also, new development shall not be allowed that would increase damage to any other property or would diminish the existing degree of flood protection that such properties enjoy unless adequate offsetting work is carried out to safeguard the existing properties.

The Alameda County Watercourse Ordinance has been adopted effective April 15, 1982. The purpose of the ordinance is to safeguard and preserve water-

[1] Conservation Foundation Letter, "Flood Plains: No Longer Up for Grabs?" (May, 1975), p 5.

courses, protect lives and property, prevent damage due to flooding, protect drainage facilities, control erosion and sedimentation, restrict discharge of polluted materials and enhance recreational and beneficial uses of watercourses.

c) Flood Control

In September 1980, the California Department of Water Management completed its California Flood Management: An Evaluation of Flood Damage Prevention Programs. This report included a status of local flood management regulations. Table 12 presents this information for the County and for cities in the County.

2. Structural Programs

a) Flood Control Projects & Programs

ACFCWCD is responsible for overall flood control planning in the County and for the installation and maintenance of facilities and implementation of programs for drainage and flood control, as well as water conservation. This district is not explicitly responsible for soil erosion control, although watercourse protection and flood control facility maintenance responsibilities have necessitated a degree of involvement in erosion control, especially related to construction activities. The District prepares plans for each of the zones. These plans which identify and design flood level standards currently vary among the several zones (e.g. 25 years in Zone 12, 15 years in Zone 3A and 100 years in Zone 5 and 6). The District will request, that the standards be increased for the 100-year flood lands throughout all zones.

Besides county projects, flood control projects are undertaken by private developers and local and federal governments and coordinated by ACFCWCD. If proposed developments are located within a flood prone area, through improvement the hazards to the property and adjacent properties must be mitigated.

The Federal Government completed 4 projects in Alameda County that minimized the risk of flood hazard to large areas of population and structures of San Leandro Creek, San Lorenzo Creek, Alameda Creek and Arroyo Del Valle. Table 13 gives a summary description of these four projects.

The largest areas subject to flood hazard in Alameda County lie within the Livermore Valley. This includes sections of the Arroyo de la Laguna and Arroyo Mocho. The Corps of Engineers is currently studying

Table 12

Regulated Floodways in Alameda County

Responsible Agency	Type of Floodway Regulation	Floodways Regulated	Type of Area Regulated	Information or Action Needed to Regulate Floodways	Eligible for Flood Insurance
Alameda County Flood Control and Water Conservation District	Building areas frozen by county ordinance	Cull Creek, Crow Canyon Creek, Alameda Creek, Arroyo De La Laguna	Urban, industrial, agricultural	Identification and regulation of remainder of flood-hazard areas in its jurisdiction	Yes
Alameda	City resolution establishing review and enforcement for flood plain management, uniform building code	Citywide - floodways not specified	Urban, industrial	Identification of flood-hazard areas	Yes
Albany	None			Identification of flood-hazard areas, codification of regulations	Yes
Berkeley	Building code, minimum elevation regulation	Tide plain	Urban, industrial	Identification and regulation of flood-hazard areas of streams and drains	Yes
Emeryville	None			Identification of flood-hazard areas, codification of regulations	Yes
Fremont	Municipal code, zoning ordinance	As shown on FEMA flood-hazard maps	Urban, industrial		Yes
Hayward	Municipal code, minimum elevation regulation, zoning ordinance	Tide plain	Industrial	Identification and regulation of flood-hazard areas of streams and drains	Yes
Livermore	None	None		Identification of flood-hazard areas, codification of regulations	Yes
Newark	City resolution, building permit system	Citywide - floodways not specified	Urban, industrial	Identification of flood-hazard areas	Yes
Oakland	City ordinance, building permit and review to minimize flood damage. City ordinance designating floodway and regulating structures to comply with Cobey-Alquist Flood Plain Management Act	Citywide - floodways not specified San Leandro Creek	Urban, industrial	Identification of flood-hazard areas	Yes
Piedmont	None			Identification of flood-hazard areas, codification of regulations	Yes
Pleasanton	General plan, building and land use controls	None		Identification of flood-hazard areas, codification of regulations	Yes
San Leandro	Municipal code, standards for constructing in flood-hazard zones. City ordinance designating floodway and regulating structures to comply with Cobey-Alquist Flood Plain Management Act	As shown on FEMA flood-hazard maps San Leandro Creek	Urban, industrial		Yes
Union City	None			Identification of flood-hazard areas, codification of regulations	Yes

SOURCE: State of California Department of Water Resources, California Flood Management, An Evaluation of Flood Damage Prevention Programs. Bulletin 199, September 1980.

Table 13

FLOOD DAMAGE PREVENTION PROJECTS IN ALAMEDA COUNTY

Stream	Flood Project	Maintaining Agency	Project Description	Area Protected	Level of Protection
San Leandro Creek	San Leandro* (U.S. Army Corps of Engineers)	Alameda County Flood Conrol and Water Conservation District	Approximately 2.9 kilometres (1.8 miles) of channel improvements	Cities of Oakland, San Leandro	The project is designed to contain floodflow of up to a 1-in-100 year flood
San Lorenzo Creek	San Lorenzo* (U.S. Army Corps of Engineers)	Alameda County Flood Control and Water Conservation District	Approximately 2.3 kilometres (1.4 miles) of leveed channel in the lower reach and a rectangular concrete channel extending upstream 6.3 kilometres (3.9 miles).	Communities of Hayward, San Lorenzo	The modifications are designed to contain floodflows up to the magnitude of a standard project flood.
Alameda Creek	Alameda Creek (U.S. Army Corps of Engineers)	Alameda County Flood Control and Water Conservation District	Approximately 21 kilometres (13 miles) of channel modification, including levees, channel enlargement, and bank protection	Communities of Niles and Union City and downstream areas	Project provides Standard Project Flood protection from Alameda Creek floodflows
Arroyo Del Valle	Del Valle Reservoir (Department of Water Resources and U.S. Army Corps of Engineers)	State Department of Water Resources	Flood storage reservation consisting of 43 200 and 3 700 cubic dekametres (35,000 and 3,000 acre-feet) primary and secondary flood storage and 1 200 cubic dekametres (1,000 acre-feet) dual water supply and flood storage	Livermore Valley. Communities of Niles and Union City, and downstream areas	The project limits Standard Project Flood outflow to 198 m^3s (7,000 cfs) providing a reduction of approximately 467 m^3s (16,500 cfs) at the dam site

* Small project

Source: State of California, Department of Water Resources, California Flood Management: An Evaluation of Flood Damage Prevention Programs, September 1980

the Arroyo de la Laguna watershed, which is south of Bernal Avenue and extends to Sunol. Among the considerations of the Corps' Upper Alameda Creek Urban Study is the improvement of Arroyo de la Laguna generally between I-680 and the vicinity of the Castlewood bridge. The inadequacy of this reach to pass the 100-year flood is the reason for most of the flood hazard in the Pleasanton area, including areas adjacent to Arroyo Mocho and Tassajara Creek. The improvement of Arroyo de la Laguna and many of the alternative methods of alleviating the flood hazard in Pleasanton may well be beyond the resources of local agencies and require federal and/or State assistance. Inadequate sections of tributary streams and channels can be improved in cooperation with local development without such assistance.

At this time, the sections of the Arroyo Mocho subject to flood hazard are located east of the Southern Pacific Railroad tracks and includes Tassajara and Chabot Creek. ACFCWCD anticipates that this section will be improved with pressure for private development.

A major effort is being mounted by the Federal Government through the Corps of Engineers Urban Study Program for the upper Alameda Creek watershed. This planning study will thoroughly investigate the total water management problems of the Livermore-Amador Valley with suggested alternatives for dealing with these problems. Flood plains for the many arroyos in the Zone No. 7 area will be one of the major elements to be evaluated by the Corps. Zone No. 7 of ACFCWCD is currently acting as local sponsor for this Federal study.

The Federal Government is also currently involved with improvements of the Temescal Creek in Oakland.

b) Emergency Operations

The County Flood Control District is responsible for control of flood waters during a flood.

There are no plans or elements which specifically determine emergency procedures for floods which are not the result of dam failures. Rather, emergency operations during a flood would follow general disaster response procedures set forth in the County and city emergency operations plans.

Flood hazard area information is available to the public. Most residents discover that a property is located in a flood hazard area when buying or selling the property. The financing institution must determine or require determination of the flood hazard status of the property and information will be communicated to the prospective buyers or sellers.

c) Tsunamis and Seiches

1) Control Projects and Programs for Tsunamis

The hazard of 100-year coastal flooding with velocity-wave action or tsunamis also falls under the jurisdiction of ACFCWCD.

These areas have been mapped and are subject to provisions of the National Flood Insurance Program. Private developers would make necessary site improvements (i.e. levees) if an area is subject to coastal flooding.

In 1979, the Corps of Engineers commenced a study of the San Francisco Bay shoreline to examine flood and related problems of lands lying along the San Francisco Bay to determine the feasibility of providing protection primarily against tidal flooding.

Also, as a demonstration project under authorization of the Shoreline Erosion Control Demonstration Act of 1974, the City of Alameda was selected and under study. The purpose of the project is to stabilize the shoreline and prevent further erosion.

2) Seiches

Dams and reservoirs in the County have not been evaluated to determine seiche potential. However, seiches would not appear to present a significant problem to public safety in that there is only very limited development along the shorelines of these waterbodies. Overtopping, resulting from seiche action, or from landslides, may cause downstream flooding.

3) Warning Systems

As with other flood related hazards there would normally be sufficient advance time before a tsunamis. Tsunami warnings normally originate from the Tsunami Warning Center in Honolulu, Hawaii. Warning times would vary with the distance from the focus of the tsunamis, but for most tsunamis approaching

the coast, several hours are available to evacuate the citizens and to undertake other emergency preparations.

D. Hazardous Materials

- Solid Waste Management Plan

  Hazardous wastes are addressed in the Alameda County Solid Waste Management Plan. The objectives and policies of that Plan state that the Alameda County Solid Waste Management Authority will cooperate with the State Department of Health and other Bay Area counties. The Authority shall be the local authority for overall management of hazardous waste; enforcement shall be performed by the State Department of Health and Division of Environmental Health.

- Hazardous Waste Disposal

  There are no Class I (hazardous waste) sites in Alameda County. Hazardous wastes are transported to a variety of sites. Hazardous wastes generated within Alameda County are transported to three sites outside of the County; in Benicia, Martinez, Kettleman and Casmalia.

- Transport

  The transport of hazardous materials is regulated by CalTrans. The transport of hazardous wastes is regulated by the State Department of Health Services. All haulers are required to register with these agencies. However, neither agency or local agency regulates or designates the route to use or times where materials can be transported.

  In the event of a road spill the local police agency is the onsite control agency. In the unincorporated portions of the county the State Highway Patrol is the primary control agency along all roadways.

- Pipelines

  Alameda County OES has developed an Alameda County Pipeline Plan, updated August 1981, which designates all pipelines, owners and shut-off valves. The owner of the pipeline is responsible if there is a leak.

- Onsite Storage and Use

  All on-site storage and use of hazardous materials require a conditional use permit by the County. Such uses are only allowed in industrially zoned areas. On-site or off-site storage, treatment and/or disposal requires a permit from State Department of Health Services.

APPENDIX A

Glossary

Alluvial fans: Alluvial fans are built by rivers flowing from mountains onto lowlands. They are low cone-shaped heaps, steepest near the mouth of the valley, and sloping gently outward with ever decreasing slope.

Alluvium: A general term for the sediments laid down in river beds, flood plains, lakes, fans at the foot of the mountain slopes, and estuaries during relatively recent geologic times.

Cohesion, rock: The capacity of a rock to stick or adhere together. In effect the cohesion of soil or rock is that part of its shear strength which does not depend upon interparticle friction.

Compaction: Decrease in volume of sediments, as a result of compression of sediments deposited above them.

Critical Facility: Includes facilities housing or serving many people or otherwise posing unusual hazards in case of damage from or malfunction during an earthquake, such as hospitals, fire, police, and emergency service facilities, utility "lifeline" facilities, such as water, electricity, and gas supply, sewage disposal, and communications and transportation facilities.

Differential Settlement: Loss of strength or the loss of water and sand through liquefaction often does not occur evenly over broad areas. Thus the ground settles different amounts in adjacent spots. Can be very destructive to buildings.

Displacement: The dislocation of one side of a fault relative to the other side resulting from fault movement.

Earth-flow: A slow flow of earth lubricated with water. Earth-flows may be discriminated from earth-slumps by reason of their greater mobility.

Earthquake: Perceptible trembling to violent shaking of the ground, produced by sudden displacement of rocks below and at the earth's surface.

Epicenter: The geographical location of the point on the surface of the earth that is vertically above the earthquake focus.

Fault: A fracture in the earth's crust forming a boundary between rock masses that have shifted.

> **Active Fault:** A fault that has moved recently and which is likely to move again. For planning purposes, "active fault" is usually defined as one that shows movement within the last 11,000 years.
>
> **Potentially Active Fault:** (1) A fault that last moved within the Quaternary Period before the Holocene Epoch (the last 2,000,000 to 11,000 years); (2) A fault which, because it is judged to be capable of ground rupture or shaking, poses an unacceptable risk for a proposed structure.

Inactive Fault: A fault which shows no evidence of movement in recent geologic time and no potential for movement in the relatively near future.

Fault Creep: Very slow periodic or episodic movement along a fault trace unaccompanied by quakes.

Fault slip or slippage: The relative displacement of formerly adjacent points on opposite sides of a fault. Also known as fault creep.

Fault system: Two or more fault sets formed at the same time.

Fault trace: The intersection of a fault and the earth's surface as revealed by dislocation of fences, roads, by ridges and furrows in the ground, etc.

Fault zone: A fault, instead of being a single clean fracture, may be a zone hundreds or thousands of feet wide; the fault zone consists of numerous interlacing small faults or a confused zone of gouge, breccia or other material.

Fire Break: A natural or artificial barrier where plants have been removed for fire-control purposes.

Fire Hazard Severity Scale: A system of classifying and delineating wildland areas of varying potential for fire using three criteria: fuel loading (in terms of wildland plants); weather; and slope.

Fire Hazard Zone: An area where, due to slope, fuel, weather, or other fire-related conditions, the potential loss of life and property from a fire necessitates special fire protection measures and planning before development occurs.

Floodway: The channel and portions of a flood plain required to carry flood flows of a 100-year flood without significantly raising the level of the flood waters.

Flood Fringe: The portion of a 100-year flood plain which is outside of the floodway.

Flood Plain: A lowland or relatively flat area adjoining inland or coastal waters that is subject to a one-percent or greater chance of flooding in any given year (i.e., 100-year flood).

Focal Depth: Depth of an earthquake focus below the ground surface.

Focus: The point within the earth which marks the origin of the elastic waves of an earthquake.

Frequency: The number of seismic wave peaks which pass through a point in the ground in a unit of time. Usually measures in cycles per second.

Fuel Break: A wide strip of land on which plants have been thinned, trimmed, pruned, or changed to types which burn with lower intensity so that fires can be more readily put out.

Fuel Loading: The quantity of plants and other fuel per unit of land area.

Fuel Management or Fuel Modification: The use or removal of plants in the wildlands to reduce the intensity of an approaching wildfire and to increase the ability to prevent or fight fires while preserving and enhancing environmental quality.

Geology: The science which treats of the earth, the rocks of which it is composed, and the changes which it has undergone or is undergoing.

Ground Cracking: Cracks usually occurring in stiff surface materials resulting from differential ground movement.

Ground Failure: A situation in which the ground does not hold together such as in landsliding, mud flows, liquefaction and the like.

Ground Lurching: Undulating waves in soft saturated ground that may or may not remain after the earthquake.

Hazardous Building: A building that may be hazardous to life in the event of an earthquake because it:

(1) Was constructed prior to the adoption and enforcement of local codes requiring earthquake resistant design of buildings;

(2) Is constructed of unreinforced masonry; or,

(3) Exhibits any one of the following characteristics:

- Exterior parapets and ornamentation that may fall on passers-by;
- Exterior walls that are not anchored to the floors, roof, or foundation;
- Sheeting on roofs or floors incapable of withstanding lateral loads;
- Large openings in walls that may cause damage from torsional forces; or,
- Lack of an effective system to resist lateral forces.

Hazardous Waste (material): A waste, or combination of wastes, which because of its quantity,concentration, or physical, chemical, or infectious characteristics may either: a) Cause, or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible, illness. b) Pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported, or disposed of or otherwise managed.

Intensity: A nonlinear measure of earthquake size at a particular place as determined by its effect on persons, structures, and earth materials. The principal scale used in the United States today is the Modified Mercalli, 1956 version. Intensity is a measure of effects as contrasted with magnitude which is a measure of energy. They are not the same.

Inundation: Flooding caused by water topping a dam or water released by dam, reservoir, levy or other break.

Isoseismic Line: An imaginary line connecting all points on the surface of the earth where an earthquake shock is of the same intensity.

Landslide: A general term for a moving mass of soil or rock, which is moving or has moved.

Liquefaction: A process by which water-saturated granular soils transform from a solid to a liquid state because of a sudden shock or strain.

Magnitude: The rating of a given earthquake is defined as the logarithm of the maximum amplitude on a seismogram written by an instrument of specified standard type at a distance of 62 miles from the epicenter. It is a measure of the energy released in an earthquake. The zero of the scale is fixed arbitrarily to fit the smallest recorded earthquakes. The scale is open ended, but the largest known earthquake magnitudes are near 8-3/4. Because the scale is logarithmic, every upward step of one magnitude unit means a 32 fold increase in energy release. Thus, a magnitude 7 earthquake releases 32 times as much energy as a magnitude 6 earthquake. Magnitude is not the same as intensity.

Maximum Credible Earthquake: The most severe earthquake that appears capable of occurring, based on present information, including (a) the seismic history of the area; (b) the length of significant faults within 100 kilometers; (c) the type(s) of faults; and, (d) the tectonic or structural history of the region.

Minimum Fire Flow: A rate of water flow that should be maintained to halt and reverse the spread of a fire.

Mudslide (Mudflow): A river, flow or inundation of liquid mud.

Physiography: A description of existing nature as displayed in the surface arrangement of the globe, its features, atmospheric and oceanic currents, climate, etc.

Potentially Hazardous Facility: Includes dams and reservoirs, nuclear reactors, tall buildings, other buildings housing many people, such as schools, prisons, and hospitals, and other structures containing large quantities of potentially explosive or toxic materials.

Reverse or thrust fault: Vertical or nearly horizontal movement along a sloping fault surface in which the block above has moved upward or over the block below the fault.

Right-lateral fault: Generally horizontal movement in which the block across the fault from an observer has moved to the right.

Sag Ponds: Ponds occupying depressions along active faults. The depressions are due to uneven settling of the ground.

Sand Boils: Turgid upward flow of water and some sand to the ground surface resulting from increased ground water pressures when saturated cohesionless materials are compacted by earthquake ground vibrations.

Sediment: Solid material settled from suspension in a liquid,

Seiche: An earthquake-induced wave in a lake, reservoir, or harbor.

Seismograph: An instrument that writes a permanent continuous record of earth vibrations.

Seismic: Pertaining to an earthquake or earth vibration, including those that are artificially induced.

Strike-slip: Fault displacement parallel to the strike of the fault.

Strong Motion: Ground motion produced by a "strong" earthquake or one capable of producing damage to structures. The magnitude of such an earthquake may vary considerably according to the character of the earthquake.

Subsidence: A shrinking of a large area of land, usually observed as a shrinkage.

Surface Rupture: A break in the ground's surface and associated deformation resulting from the movement of a fault.

Tectonic: Pertaining to or designating the rock structure and external forms resulting from the deformation of the earth's crust. Pressures causing such deformations often result in earthquakes.

Topography: The physical features of the land, especially its relief and contour.

Tsunami: A wave, commonly called a tidal wave, caused by an underwater seismic disturbance, such as sudden faulting, landslide, or volcanic activity.

Wildland: A nonurban, natural area which contains uncultivated land, timber, range, watershed, brush or grasslands.

SOURCES:

The Seismic Safety Study, a joint planning study of the cities of El Cerrito, Richmond and San Pablo, 1973.

General Plan Guidelines, State of California, Office of Planning and Research, September 1980.

Appendix B

Specific Description of Ground Failures in Alameda County

Location No.	Figure No.	Failure type	Accuracy	Year of earthquake	Reference	Quotation
144			B	1906	Schussler, 1906, p. 32.	Neither the Sunol filter beds, on the Alameda Creek System, nor the Sunol Aqueduct and 36-inch pipe line, on the east side of the bay, nor the four submarine [under San Francisco Bay] pipe lines were injured; only a slip-joint, on one of the two 16-inch shore connections, was pulled apart several inches, on the east side of the bay * * * .
			A	1906	Gilbert, Humphrey, Sewell, and Soulé, 1907, p. 116.	(See the maps, Pls. LVI and LVII.) Some subaqueous pipe lines crossing the bay seem not to have been injured.
162			C	1906	Duryea and others, 1907, p. 258.	Between Niles and San José, on the Southern Pacific, there was at one point a displacement of 3 ft. horizontal, but the vertical displacement was only 6 in.
163			C	1868	Lawson and others, 1908, p. 444.	On the mountain above the old Mission, just above a place called Peacock Springs, a great crack in the earth appeared, which lookt as if the lower part of the mountain had parted and slipt down. Many times I have crost the bridge which was built over the crack, and stopt and thrown rocks down to see if I could tell how deep it was. (Mrs. N. Ainsworth.)
164			B	1906	Lawson and others, 1908, p. 304.	According to the track-boss, the railroad track suffered no displacements anywhere between Niles and Irvington.
165			A	1906	Lawson and others, 1908, p. 306.	While at Niles, a visit was made to one of the new tunnels of the Western Pacific Railway, which is about 1 mile east of Niles in the Niles Canyon. The tunnel had penetrated about 130 feet into the hillside, but had not yet passed thru anything but a sandy clay During the previous winter the walls at the portal, and also on the inside, had stood without timbering. Since the earthquake it had been impossible to break out more than 4 feet of ground ahead of the timber sets without caving taking place. There had been an apparent movement in the soil which had removed its consistency and made it incoherent. The amount of water present in the tunnel was perceptibly changed. The foreman said that there was more water since the shock than there had been even in the wettest part of the winter.
			C	1933	Coffman, 1973, p. 169.	*1933. May 16.* Niles Canyon * * * Landslide * * * .
166			B	1906	Lawson and others, 1908, p. 309, plate 141A.	At the Alviso ranch, a little over a mile north of the town [Livermore], the top of a small hill was broken up at the time of the earthquake. The breaking of the ground did not consist of fissuring along a line, but was in the nature of an uplift of a limited area. There were 3 fairly well marked concentric rings where the ground had broken, the inside ring in each case being forced higher than the outside ring. The effect was similar to that obtained by placing three plates of different sizes within each other. * * * Mr. Still reports that where the ground was deformed in concentric ridges, as described by Mr. Matthes and Mr. Crandall, there was an alkaline spring years ago. [A somewhat similar phenomenon was seen on Cahill's ridge (locs. 116, 120) in San Mateo County.]
			B	1906	Lawson and others, 1908, p. 308, plate 141A.	An interesting feature appears 0.25 mile north of Meyn's ranch, west of the road leading north from Livermore, about 2 miles north of that place. It is on the summit of a smoothly rounded hill, sloping gently down to an even, peaty meadow traversed by the arroyo of Cayetana Creek. * * * The summit of the hill in question was found crowned by a series of concentric deformations, rising stepwise above one another. A number of nearly concentric cracks were found extending northward into a sort of panhandle, along each of which an upward movement of the soil had apparently taken place. The uplift along the 2 principal cracks was found to be 19 and 16 inches, respectively. Along the minor cracks the vertical displacement amounted to an inch or two only. The surface of each step or bench was found to slope inward, and in some places the edge even appeared to have curled inward.

Specific Description of Ground Failures in Alameda County

Location No.	Figure No.	Failure type	Accuracy	Year of earthquake	Reference	Quotation
167			B	1906	Lawson and others, 1908, p. 309.	*Santa Rita*, 3 miles east of Dublin (F. E. Matthes).--A small, flat levee along the east bank of Tassajara Creek, immediately north of the main road, showed several somewhat crescentic cracks along which the ground had slipt down and toward the creek from 1 to 3 inches. These cracks extended farther south, according to local settlers, and crost the road; but this was no longer traceable at the time of the visit.
168			C	1861	Holden, 1898, p. 58.	1861. July 4?; 16h. 11m. . . . in the San Ramon Valley . . . . It opened a large fissure in the earth, and a new spring of water.
			C	1861	Coffman, 1973, p. 157.	*1861. July 3.* Contra Costa and Alameda Counties. Severe . . . . In San Ramon Valley a fissure opened, and a new spring of water appeared.
169			C	1906	Lawson and others, 1908, p. 280.	The track suffered a slight shifting in several places north of the village [Newark]. Cracks opened in the ground in the vicinity of 2 small watercourses, but on a less extensive scale than that noted at Alvarado [loc. 170]. Some of them crost the railroad track. In every case they emitted the same bluish sand (with the water) that had been found near the Alameda Sugar Mill. In one place, 1.5 miles northeast of the village, considerable water was still left standing in shallow ponds. According to neighboring ranchmen, these ponds had not existed prior to the earthquake.
			C	1906	*Oakland Tribune*, 1906a.	Newark, April 18.--About a mile north of this town a fissure was opened by the earthquake. This fissure is about a mile and a half in length and from eight to twelve inches in width. From the fissure quantities of water are being emitted, although the land is in what might be termed a dry district.
			C	1906	*The Bulletin*, 1906.	Fissure created by earthquake near Newark becomes running water, and pipe wells become gushers spouting twelve feet. One of the most peculiar freaks of the great temblor of last Wednesday morning is a fissure in the earth a short distance from Newark, several feet wide and about a mile and a half long, running with an excellent quality of water. This river was first noted by the crew of one of the Southern Pacific Company's trains coming up from San Jose, and investigation discloses that many of the old pipe wells in the vicinity have suddenly gushed forth, in some instances the water spouting from eight to twelve feet into the air.
170			B	1906	Lawson and others, 1908, p. 305.	The [Alameda Sugar] mill stands on flat, alluvial ground 100 feet north of Alameda Creek. Along the banks of the latter a large number of cracks extend, roughly parallel with the stream. Considerable masses next to the stream-bed slumped toward the same, leaving gaping cracks 1 to 2 feet wide, and carrying with them small outlying buildings, notably the fire-engine house, which moved bodily, concrete foundation and all, 2 feet south toward the creek. A small railroad trestle southwest of the mill moved 4 inches south on both of its abutments, probably owing to slumping of loose ground on the north side of the creek. A 2-inch water-pipe, laid under the ground some 60 feet north of the creek and almost parallel with the same, shows indications of having been submitted first to tension, causing rupture at one of the joints, then to sudden compression, causing it to be jammed together with violence. Cracks in the ground may be found as far as 250 feet from the creek. They were nearly all closed at the time of the visit (May 7), but were easily traced by the streaks of bluish-gray sand which has issued from them, together with considerable quantities of water. According to the Chinese cook of the superintendent, the cracks nearest to his dwelling opened and closed several times in succession during the quake; and large volumes of mud-laden water gushed from them, splashing up some 10 feet in the air at each closing. A large crack of this kind opened under the northwest corner of the dwelling and the superintendent estimates that fully 500 gallons of water

Specific Description of Ground Failures in Alameda

Location No.	Figure No.	Failure type	Accuracy	Year of earthquake	Reference	Quotation
						gushed from it, the flow continuing with decreasing volume for about an hour. The fence in front of the house shows that the ground there has been raised into a low hump. The sewer pipe leading west to the creek was detached from the house by a space of 22 inches. * * * In the roadway south of the mill, water oozed out in a number of places, without the production of visible cracks. The water pipes and hydrants in this vicinity were crusht in several places. * * * A few cracks opened across the streets [of Alvarado], but these had been filled on the date of the visit.
			C	1868	Lawson and others, 1908, p. 443.	*Alvarado.* * * * The ground opened in several places and water issued.
			B	1906	Duryea and others, 1907, p. 254.	At Alvarado, near the pumping station, the 30-in. riveted-iron force main conducting the water to Oakland crosses the Alameda Creek on a short bridge. * * * In this pipe was placed a 24-in. stop-gate resting on a concrete foundation. The piles under the pipe were not deeply placed; and the shake operated to settle them irregularly, some going down as much as 6 in.
			B	1906	Hyde, 1906c, p. 766.	ALVARADO FORCE MAIN.-- * * * The earthquake threw this pipe out of alignment into a decidedly sinuous location for a distance of about one-half mile. The flanges of the gate valve were broken by the unequal settlement of the trestles carrying the pipe and the concrete pier on which the valve rests.
			B	1906	Derleth, 1906a, p. 503.	The Alvarado force main, a riveted pipe, was wrenched in two places. Three hundred feet from the pumps the pipe snapped, and a quarter of a mile further on toward the city, in which distance the pipe lies upon piling, the flange of a large gate valve was broken by the settling of the piles.
			B	1906	Duryea and others, 1907, p. 249 and p. 250.	[At the pumping station] on the marsh land near the Bay shore, one mile west of Alvarado. * * * * * * the foundation settled about 2 ft., breaking all the pipe connections. During the quake the channel of the creek disappeared, its bottom being raised to the general level of the adjoining land.
171			B	1868	Lawson and others, 1908, p. 443.	The ground opened from 6 inches to 2 feet, and water with sand was ejected to a height of from 1 to 3 feet. North of the village [Hayward] a ridge of ground 3 feet wide was raised 2 feet. * * * On the hills there were several new springs.
			B	1868	Lawson and others, 1908, p. 442.	The crack below Haywards Hotel was 12 inches wide. It ejected water and white sand. A fence which traversed a hill from north to south was crost by the crack, and had the ends of the boards loosened from the posts. Gradually these boards lapt over one another, until within a couple of weeks they overlapt several inches, the progress of the overlapping being noted from time to time by a pencil mark. The "cap" board of the fence was also archt up in consequence of this movement. Large waves were set up in the soil. The house was moved southward, while a neighbor's was tipt northward. (D. S. Malley.)
			C	1868	Lawson and others, 1908, p. 442.	On B Street the ground opened about 2 inches, and water and sand were forced from the opening. Some springs were closed, while others were opened or made to flow more freely.
			C	1868	Lawson and others, 1908, p. 435.	In the vicinity of Haywards it is reported that there were two branch cracks from the main one [fault?], trending off into the hills. Water and sand were ejected from the crack in one place.
172			C	1838	Wood, Allen, and Heck, 1939, p. 3.	1838, late in June. * * * VIII at least. * * * Landslide at San Leandro.
			C	1868	Halley, 1876, p. 263.	The bed of the San Leandro creek, which had been dry for several months, is now coursed by a stream of water six feet wide and one foot deep. Back of San Leandro, in the mountains, there are numerous fissures in the earth, from which came clouds of dust, and from some have come great volumes of water which flows into the San Leandro Creek.

Specific Description of Ground Failures in Alameda County

Location No.	Figure No.	Failure type	Accuracy	Year of earthquake	Reference	Quotation
			B	1868	Halley, 1876, p. 267.	A Mr. Davis, who resides on a farm near San Leandro, informs the *Bulletin* that the workmen on his farm at the time the shock occurred, observed that the ground was disturbed and thrown about with a rapid and violent rotary motion, which continued several seconds. A creek running through the farm, and which was nearly dry, rose instantly to the depth of about three feet, and several deep gulches were formed in the plain.
173			B	1906	Lawson and others, 1908, p. 304.	* * * at Mills College * * * In the made ground there was a drop of from 1 foot to several feet.
			C	1906	*Alameda Daily Argus*, 1906.	[At Alameda] * * * damaged tracks in the marsh. One of the new tracks of the Oakland Traction Company across Webster St. sunk about four feet and the rails are twisted, blocking traffic.
174			C	1906	Derleth, 1906a, p. 503.	The [water] distribution system of East Oakland seems to be practically unaffected, but in West Oakland, upon filled ground, some of the smaller pipes and some of the service connections have been broken, but the damage is, relatively speaking, slight.
			C	1906	*Alameda Daily Argus*, 1906.	Bay Farm Island shows many crevices and cracks on the surface.
			C	1906	*The Evening Post*, 1906b.	Railroads are inactive, and wires are useless. Railroad tracks across the marsh are twisted. * * * More than 600 feet of the track of the Oakland Transit Company sank nearly four feet.
			B	1906	Duryea and others, 1907, p. 254.	One 12-in. cast-iron pipe near the water front in East Oakland was drawn apart at the joint, and one or two breakages occurred on a long line of 8-in. pipe leading to the Southern Pacific Railroad Broad-Gauge Pier.
			B	1868	Holden, 1898, p. 76 and 77.	1868. October 21; IX. Oakland. * * * The draw of the railroad bridge was thrown twelve inches out of line.
			B	1906	*Oakland Enquirer*, 1906.	The magnesite works at the foot of Ninth avenue in East Oakland have sunk several feet and now the ground on which they stood is under water. The sinking is probably due to the violent earthquake of Wednesday morning. The land on which the works stand is very unsubstantial, being simply built up by the process of dredging.
			C	1906	*Leslie's Weekly*, 1906a.	[Picture caption] Frame structure which was cracked and wrenched and which sank for several feet into the yawning ground.
			B	1868	Halley, 1876, p. 266.	The drawbridge on the line of the S. F. and O. R. R. was thrown out of place about eight inches, and as the locomotive and nearly all the cars were at San Antonio, no train left Oakland at 8 o'clock.
175			A	1906	Derleth, 1906a, p. 503.	The earthquake did not produce, relatively speaking, much destruction to these [Oakland, Alameda, and Berkeley water systems] works. Breaks in the pipe lines invariably were found upon soft ground, or where the pipe lines passed from soft and yielding to more rigid foundation. * * * The 24-in. steel pipe crossing the Twelfth St. dam at Lake Merritt was also snapped from the settling of the flood gates, but the 37 1/2-in. pipe running parallel and slightly to the east, across the same soft foundation bed was only slightly deformed.
			A	1906	Lawson and others, 1908, p. 302.	On the Twelfth Street dam, a cast-iron pipe was broken and displaced over a foot; while the high pressure steel pipe paralleling it was practically undisturbed.
			A	1906	*Oakland Tribune*, 1906b.	Menaced by Water. The tide at the time of the earthquake was at its lowest, and at the time of writing it has turned and running into Lake Merritt. What will happen when the lake is filled and the backing of the water pressures with great force on this portion of the dam is something that can not be foretold. The rock foundation of the dam at this point is cracked and broken and gives indications of giving away at any time.

Specific Description of Ground Failures in Alameda County

Location No.	Figure No.	Failure type	Accuracy	Year of earthquake	Reference	Quotation
						REPAIRS DAMAGE Secretary Hanson of the Contra Costa Water Company was early on the scene and with a force of men began at once to repair the water main so that the people of the city could have water for the protection of their homes in case of fire. It is not expected that water will be turned on before this afternoon The great main has sunken with the street and broken in two and parted for the space of several inches and the pipe will have to be uncovered and a new length put in or the pipe drawn together.
						Along the west shore of Lake Merritt the bank has been cracked and broken and caved off into the lake, showing the force of the shake at the water level.
176			C	1906	Duryea and others, 1907, p. 254.	A 24-in. riveted pipe lying in a street leading across a tide marsh in Oakland was pulled apart 5 in. and displaced 8 in. laterally by the settling of the entire street.
			C	1906	Rickard, 1906a, p. 271.	* * * the lower alluvial flats of Oakland and Berkeley were seriously disturbed * * * .
			B	1868	Wood, M.W., 1883, p. 665.	October 21, 1868. [Oakland] Portions of the wharves were carried away in some instances, while walls were cracked in almost every house * * * .

SOURCE: <u>Historic Ground Failures in Northern California Associated with Earthquakes</u>, Geological Survey Professional Paper 993, 1978.

Appendix C

Goals and Objectives: 1976 Seismic Safety Element and Safety Element

SEISMIC SAFETY ELEMENT (1-8-76)

Goals: County wide and Unincorporated Area

1. To the greatest possible extent, protect citizens, land and structures within Alameda County from the hazardous results of seismic activity. Del.

2. To coordinate seismic protection activities with all state, regional and local agencies. Del.

3. To educate and inform the public at large and land developers on seismic activity and protective measures. Del.

Objectives: Countywide

1. Prepare, adopt and implement seismic policies, plans and legislation on a countywide basis to reduce hazards of seismic activity. Del.

2. Establish a Countywide information collection, storage and retrieval system for seismic activity to reduce duplication of efforts at the regional, County and local level. Ret.

3. Coordination with cities within the County to develop rational land use and emergency service plans. Del.

4. Develop a seismic educational program for use by schools, developers and the public at large. Del.

Objectives: Unincorporated Area

1. Provide an acceptable level of safety from seismic hazards by continuing to assess and evaluate local geology and structures and take action to abate public safety hazards. Del.

2. Develop a rational land use plan based upon knowledge of local geologic conditions and potential seismic events. This would involve the development of seismic constraint maps which would than be applied to land use plans. Del.

SAFETY ELEMENT (1-8-76)

COUNTYWIDE POLICIES

Fire Hazards

Goal #1: Persons, property, and natural resources in Alameda County should be protected from the ravages of fire to the greatest extent possible. Del.

Goal #2: Structural and wildland fire hazards should be recognized as unacceptable hazards in all areas of the County, and County and local governments should be responsible for minimizing the risk of fire in both urban and rural areas. Del.

Goal #3: Because human activity is the primary cause of fire, the general public should be cognizant of fire hazards and safety measures. Del.

Objective #1: Future decisions regarding the most appropriate use of land should be made with full awareness of possible impact on fire potential and public safety. The concept of land use capability in terms of appropriateness of the land for urbanization and public use should give consideration to areas of fire hazard, the availabilityof public water supply, and fire protection services. Del.

Objective #2: Information on fire hazards and fire prevention should be readily available to decision-makers and the general public. Ret.

Objective #3: All fire protection agencies in the County should develop and implement fire safety education programs, especially in the schools and in recreational areas. Ret.

Principle #1: Any program to reduce the risk of fire to County residents and resources should be coordinated with the appropriate State and local fire prevention/control agencies. Ret.

Principle #2: The level of risk associated with fire is unacceptable; therefore, it is appropriate for local government to act to safeguard life, property, and natural resources. Del.

Flood Hazards

Goal #1: Land use planning should balance the degree of flood hazard with community land use needs to determine the most appropriate use for areas subject to flood hazards and to promote public safety. Del.

Goal #2: Alameda County residents, businesses, and farmers should not be subjected to high levels of risk of property damage and personal injury caused by flood waters. Del.

Objective #1: Areas subject to flood hazards should be accurately identified and the severity of the hazard determined. Del.

Objective #2: All jurisdictions should cooperate with local and regional emergency/disasterplanning agencies in the development of dam failure (and flood plain inundation) evacuation plans. Ret.

Objective #3: A flood warning system should be developed by the local Offices of Emergency Services for present occupants of flood hazard areas. Ret.

Principle #1: Flood hazards present an unacceptable level of risk of injury and financial hardship to the public, and local and regional and state governments should assign a high level of priority to the minimization of flood hazards. Del.

Principle #2: All levels of government should develop flood-conscious policies towards management of flood plains and reservoirs. Del.

Geologic Hazards

Goal #1: The present level of risk of property damage and/or personal injury associated with geologic hazards requires that the County and the cities should act to reduce these risks wherever possible. Del.

Goal #2: County residents should be aware of the hazards and risks associated with landslides and other geologic hazards and should be informed of measures to minimize or avoid hazards caused by these environmental limitations. Del.

Objective #1: All areas subject to geologic hazards should be identified and the degree of risk determined. Del.

Objective #2: A preconstruction assessment of landslide and soil hazards should accompany proposals for development or construction of public works and utilities. Del.

Objective #3: Information on geologic hazards present in the cities and the unincorporated areas should be readily available to the public. Del.

Principle #1: It is local governments' responsibility to protect the public from severe geologic hazards in determining future land use capabilities by informing the public of the risks involved and by restricting the use of especially hazardous areas where human activity would aggravate existing limitations. Del.

UNINCORPORATED AREA POLICIES

Fire Hazards

Goal #1: Residents in the unincorporated areas of Alameda County should have a reasonable degree of fire protection service available, and the costs should be equitably shared by all persons benefitting from the provision of such services or appliances. Del.

Goal #2: The natural environment should be protected from destruction by fires resulting from human carelessness and lightning. Del.

Goal #3: Future decisions regarding development in areas lacking a public water supply and/or fire protection services within a reasonable distance should be based on an awareness of fire hazards and the project's impact on fire potential. Del.

Objective #1: Alameda County should discourage the proliferation of structures, including homes and places of public assembly, in areas lacking a public water supply and/or nearby fire fighting facilities until specific provisions are made for these services. Del.

Objective #2: The County needs to develop a comprehensive policy towards fire control in the unincorporated area. The Board of Fire Commissioners should evaluate the fire protection program and standards in the Fire Protection Districts and County service areas to determine where modifications are needed. Del.

Objective #3: The State Department of Conservation, Division of Forestry should develop guidelines which can be used by local agencies for the evaluation of any proposed development in wildland areas and its impact on fire hazard potential. Del.

Objective #4: Alameda County should prescribe minimum design standards as required for adequate fire protection for all types and size of development in the unincorporated, rural areas which have been determined to be suitable for development or public recreational use. Del.

Objective #5: To assist local governments in determining appropriate fire protection standards, the California Division of Forestry should outline fire prevention and control standards for subdivisions located in or adjacent to wildland areas. Del.

Principle #1: All privately owned reservoirs in the wildlands should be available for use by fire suppression agencies in fighting structural fires. Del.

Flood Hazards

Goal #1: Land use planning in the unincorporated area should be compatible with the severity of the flood hazard (where a hazard exists) and with County land use needs. Del.

Goal #2: Natural watercourses should be preserved in accordance with their ecological significance and with aesthetic principles of channel design where flood control works are necessary. Del.

Goal #3: Residents in the unincorporated area should be cognizant of potential flood problems and safety measures to mitigate the hazards should a flood disaster occur. Del.

Objective #1: The County should promote flood-conscious land use planning through the implementation of regulatory and non-regulatory techniques of flood plain management. Del.

Objective #2: The County should promote flood-conscious governmental policies for governmental land uses (bridges, roads, libraries, and schools, etc.) in order to reduce losses associated with a flood disaster and to control development in flood hazard areas. Del.

Objective #3: The County should promote flood-conscious policies in the extension of sanitary sewers and other public facilities and services to flood hazard areas. Del.

Geologic Hazards

Goal #1: Areas of severe geologic hazards should be protected from land uses which would aggravate existing hazards or which would subject County residents to unnecessary risk. Del.

Goal #2: Measures to decrease the potential for geologic disasters should be implemented in those areas where severe hazard is present and where human alteration of the environment has already occurred. Del.

Objective #1: Thorough geologic investigations should be undertaken before a project is approved in areas subject to landsliding and shrink-swell soils. Del.

Objective #2: All areas of the unincorporated area which are exposed to geologic hazards are to be identified and the degree of risk determined. Del.

Objective #3: Land use capability decisions are to be based on comprehensive studies of the geologic setting, historical geologic events, a forecast of the decision's effect on the geologic features of the area, and the geologic reaction to changed conditions over time. Del.

Objective #4: Reservoirs should be examined with respect to landslide hazards to determine the potential for flood disaster caused by overtopping and to develop a program to reduce the hazard if necessary. Del.

APPENDIX D

THE COUNTY PLANNING COMMISSION OF ALAMEDA COUNTY
HAYWARD, CALIFORNIA

RESOLUTION NO. 82-17 AT MEETING HELD MAY 17, 1982

Introduced by Commissioner Shockley

Seconded by Commissioner Spiliotopoulos

WHEREAS pursuant to the provisions of the Planning Law (Title 7 of the Government Code) it is the function and duty of the County Planning Agency of Alameda County California, to prepare and of the County Planning Commission to approve a comprehensive long-term general plan and general plan elements for the physical development of the county, such plan to be known as the General Plan; and

WHEREAS said Planning Law provides that a General Plan shall include a Seismic Safety Element, and a Safety Element; and

WHEREAS said Elements were adopted by the Board of Supervisors in January, 1976; and

WHEREAS changed conditions require revisions to said Elements;and

WHEREAS this County Planning Agency in coordination with cities and public and quasi-public agencies in the County has prepared amendments to said text containing objectives for the above named elements for the incorporated and unincorporated areas of the County; and

WHEREAS this Commission did announce its intent to consider amendment to said text and maps for the Seismic Safety and Safety Elements; and

WHEREAS duly noticed public hearings were held to consider said text and maps for the Seismic Safety and Safety Elements on April 19 and May 3, 1982; and

WHEREAS in accordance with California Environmental Quality Act and State and County EIR guidelines an initial study was conducted, after due notice it was determined that there were no significant impacts and Negative Declaration was prepared and approved concurrent with this action; NOW THEREFORE

BE IT RESOLVED that this Commission does hereby approve the Seismic Safety and Safety Elements comprising the document entitled "Revised Draft Seismic Safety and Safety Elements of the County of Alameda General Plan", and does recommend public hearings and early adoption by the Board of Supervisors of the said Elements.

Adopted by the Following Vote:

AYES: Commissioners: Tully, Douglas, Shockley and Spiliotopoulos

NOES: Commissioner Sutherland

ABSENT: Commissioners Bernhardt and Warren

ABSTAINED:

[illegible] PLANNING DIRECTOR AND SECRETARY
COUNTY PLANNING COMMISSION OF ALAMEDA COUNTY

APPENDIX E

REEL ________ IMAGE

August 5, 1982
Approved as to Form
RICHARD J. MOORE, County Counsel

By .... Deputy

THE BOARD OF SUPERVISORS OF THE COUNTY OF ALAMEDA, STATE OF CALIFORNIA

On motion of Supervisor Bort, Seconded by Supervisor Santana
and approved by the following vote,
Ayes: Supervisors Cooper, George, Santana and Chairman Bort - 4
Noes: Supervisors None
Excused ~~or Absent~~. Supervisor~~s~~ Excell - 1

THE FOLLOWING RESOLUTION WAS ADOPTED: NUMBER 194243

ADOPT SEISMIC SAFETY AND SAFETY ELEMENTS
OF THE ALAMEDA COUNTY GENERAL PLAN

WHEREAS, this Board of Supervisors did receive Resolution No. 82-17 from the County Planning Commission of Alameda County which contained approval of and recommendation to this Board for adoption of amendments to the Seismic Safety and Safety Elements of the Alameda County General Plan; and

WHEREAS, pursuant to the provisions of the Planning Law (Title 7 of the Government Code of the State of California), this Board held public hearings to consider said amendments to text and maps for the Seismic Safety and Safety Elements on July 1 and August 5, 1982; and

WHEREAS, this Board did consider the Negative Declaration and related documents in said amendment to the elements;

NOW, THEREFORE, BE IT RESOLVED that this Board of Supervisors does and hereby adopts said amendments to the Seismic Safety and Safety Elements of the Alameda County General Plan; and

BE IT FURTHER RESOLVED that this Board approves said Negative Declaration; and

BE IT FURTHER RESOLVED that said Elements shall be reviewed within one year by the Planning Commission and this Board of Supervisors.

BIBLIOGRAPHY

Alameda, City of, Planning Department, Seismic Safety Element - City of Alameda, Policy Section and Technical Section, Alameda, May 1976.

Alameda County Board of Supervisors, Livermore-Amador Valley Planning Unit General Plan (A Part of the Alameda County General Plan), November 1977.

Alameda County Flood Control and Water Conservation District, Report on Alameda County Flood Control and Water Conservation District Zone Programs, April 1977.

Alameda County Office of Emergency Services, Alameda County Emergency Operations Plan, revised to March 1980.

Alameda County Office of Emergency Services, Dam Failure and Evacuation Plan, revised to 1979.

Alameda County Planning Department, Appendix B - Supplementary Goals and Policies to the General Plan for the Central Metropolitan, Eden and Washington Planning Units, Hayward, 1980.

Alameda County Planning Department, General Plan for the Central Metropolitan, Eden, and Washington Planning Units, Alameda County, California, Hayward, July 7, 1980.

Alameda County Planning Commission, Safety Element of the Alameda County General Plan, Hayward, January 1976.

Alameda County Solid Waste Management Authority, Solid Waste Management Plan, Solid Waste Management Planning, November 1980, as amended 1981.

Alameda County Planning Commission, Seismic Safety Element of the Alameda County General Plan, Hayward, January 1976.

Alameda County, Contra Costa County, Santa Clara County, et al, Ridgelands - A Multijurisdictional Open Space Study, May 1977.

Alameda County Building Code, effective October 1, 1977.

Angus McDonald & Associates, Inc., A Public Service Plan and Fiscal Analysis for the Proposed Northbluff Development, prepared for Broadmoor Development Company, Berkeley, California, April 1981.

Anton, Walter F., "A Major Utility Prepares for Earthquakes," Lifeline Earthquake Engineering the Current State of Knowledge 1981, editor, D.J. Smith, Jr., American Society of Civil Engineers, New York, 1981.

Association of Bay Area Governments, Earthquake Insurance Issues, Berkeley, September 1977.

Association of Bay Area Governments, A Guide to ABAG's Earthquake Hazard Mapping Capability, March 1980.

Association of Bay Area Governments, Hazard Evaluation for Disaster Preparedness Planning, Berkeley, April 15, 1981.

Association of Bay Area Governments, Land Capability Analysis for Planning and Decision Making, February 1976.

Association of Engineering Geologist, Geology, Seismicity, and Environmental Impact, Publisher's Los Angeles, California, Special Publication, October 1973.

Berkeley, City of, Comprehensive Planning Department, Berkeley Master Plan - Seismic Safety/Safety Element, Berkeley, January 1976.

Bolt, Bruce A., Earthquake: A Primer, W.H. Freeman and Company, San Francisco, 1978.

Bonilla, M.G., and Lienkaemper, J.J., and Tinsley, J.C., Surface Faulting near Livermore, California Associated with the January 1980 Earthquakes, United State Department of the Interior, Geological Survey, Open file series 80-523, 1980.

Borcherdt, R.D., editor, 1975, Studies for Seismic Zonation of the San Francisco Bay Region, U.S. Geological Survey Professional Paper, 941-A.

*Brown R.D. Jr., (1970): Faults That Are Historically Active or That Show Evidence of Geologically Young Surface Displacement, San Francisco Bay Region, A Progress Report: October, 1970. U.S. Geological Survey, U.S. Department of Housing and Urban Development, Menlo Park, California, San Francisco Bay Region Environment and Resources Planning Study, BDC-7.

*Brown, R.D. Jr., and Lee, W.H.K., (1971): Active Faults and Preliminary Earthquake Epicenters (1969-1970) in the Southern Part of the San Francisco Bay Region, U.S. Geological Survey, U.S. Department of Housing and Urban Development, Menlo Park, California, San Francisco Bay Region Environment and Resources Planning Study, BDC-30.

*Burford, R.O., (1975): U.S. Geological Survey, Menlo Park, California, Personal Communications.

*Burkland and Associates, Inc., (1975): Geologic and Seismic Hazards Investigation for Tract 3606, Pleasanton, California, Report to Applied Soil Mechanics, Inc., by Burkland and Associates, Inc., Mountain View, California.

*From portion of Seismic Safety Element of the Alameda County General Plan, January 1976.

Burkland and Associates, Inc., Geologic and Seismic Hazards Investigation -Union City, March 1974.

*Burkland and Associate, Inc., (1973): Geological Investigation Report, Lands of Hansen and Banke, Dublin, California, Report to McKay Homes by Burkland and Associates, Mountain View, California.

*Burkland and Associates, Inc., (1975): Supplemental Investigation Dublin Green, Dublin, California, Report to Engeo, Inc., by Burkland and Associates, Mountain View, California.

California, State of, Joint Committee on Seismic Safety, Meeting the Earthquake Challenge, Final Report to the Legislature, California Division of Mines and Geology, Special Publication, January 1974.

California, State, of, Division of Mines and Geology, "Geologic Hazards: Landslides," Mineral Information Services, Vol. 20, No. 10 (October 1967).

*California, State of, Division of Mines and Geology, (1974): Potential Seismic Hazards in Santa Clara County, California, Special Report 107, California Division of Mines and Geology, Sacramento, California.

California, State of, Division of Mines and Geology, Proposed Special Studies Zones of July 1, 1981.

California, State of, Division of Mines and Geology, Urban Geology Master Plan of California, 1973.

California, State of, Department of Forestry, Fire Safe Guides for Residential Development in California, May 1980.

California, State of, Department of Water Resources, California Flood Management: An Evaluation of Flood Damage Prevention Programs, Bulletin 199, Sacramento, September 1980.

*California, State of, Department of Water Resources, (1966): Evaluation of Groundwater Resources, Livermore and Sunol Valleys Bulletin No. 118-2, Appendix A: Geology, California Department of Water Resources, Sacramento, California.

California, State of, Office of Planning and Research, General Plan Guidelines, Sacramento, September 10, 1980.

Conservation Foundation Letter, "Flood Plains: No Longer Up for Grabs?" May 1975.

Contra Costa County Planning Department, Seismic Safety Element Technical Background Report, August 1975.

*From portion of Seismic Safety Element of the Alameda County General Plan, January 1976.

Converse, Davis, and Associates, Proposed Seismic Safety Element of the General Plan for the City of Piedmont, California, Piedmont, December 1974.

The County Supervisors Association of California, Be Fire Safe! Fire Safety Guides for California, March 5, 1965.

Crockerham, R.S., Lester, F.W., Ellsworth, W.L., A Preliminary Report on the Livermore Valley Earthquake Sequence January 24 - February 26, 1980, U.S. Department of the Interior, Geological Survey, Open File Report 80-714, 1980.

Duncan and Jones, Albany, California, Preliminary General Plan, Albany, June 1974.

Earth Sciences Associates, City of Newark, California, General Plan -Seismic Safety and Safety Element, Newark, July 1976.

Ellsworth, W.L., and Marks, S.M., Seismicity of the Livermore Valley, California Region 1969-1979, United State Department of the Interior, Geological Survey, Open File series 80-515, 1980.

Emeryville, City of, Planning Department, City of Emeryville General Plan, August 1975.

Fremont, City of, Community/Economic Development Department, Seismic Safety and Safety Elements of the General Plan, Fremont, June 1975.

*Gibson, W.M., and Wollenberg, H.A., (1968): Investigations for Ground Stability in the Vicinity of the Calaveras Fault, Livermore and Amador Valleys: Geological Society of America, Bulletin V-79 p 627-738.

Goldman, Harold B., Hayward Shoreline Environmental Analysis, prepared for the Hayward Area Shoreline Planning Agency, July 1973.

*Greensfelder, R., (1974): Maximum Credible Rock Acceleration from Earthquakes in California, Map, California Division of Mines and Geology, Sacramento, California.

Hart, Earl W. Geologist, Fault - Rupture Hazard Zones in California, Alquist -Priolo Special Studies Zones Act of 1972 with Index to Special Studies Zones Maps, California Division of Mines and Geology, Special Publication 42, 1980.

Hart , Earl W.; Bryant, William B; Smith, Theodore C.; Bedrossian, Trinda L.; and Smith, Drew P.; Summary Report: Fault Evaluation Program, 1979-1980 Area (Southern San Francisco Bay Region), California Division of Mines and Geology, Open File Report No. OFR 81-3 SF.

Hayward, City of, Planning Commission Sub-Committee on Land Use and Development Regulations, Hayward Earthquake Study, Hayward, April, 1972.

*From portion of Seismic Safety Element of the Alameda County General Plan, January 1976.

Hurley, Charles, "Bracing Ourselves Special Report on LBL's Earthquake Preparedness," LBL News Magazine, Vol. 5, No. 4, Winter 80-81.

Tacopi, Robert, Earthquake Country, A Sunset Book, Lane Publishing Co., Menlo Park, California, April 1980.

Insurance Service Office, Grading Schedule for Municipal Fire Protection, 1973.

*Judd Hull and Associates, (1975): Soil Engineering and Geologic Investigation, Phase II-Site Suitability, Old Pitch and Putt Course, Report to Board of Directors, the Castlewood Country Club by Judd Hull and Associates, Hayward, California.

Livermore, City of, Planning Department, Livermore Community General Plan, 1976-2000, Livermore, March 1976.

Margerum, Terry, Will Local Government be Liable for Earthquake Losses? Association of Bay Area Governments, January 1979.

*Messigner, C., (1975): Engineering Geologist, Terrasearch, Inc., San Jose, California, Personal Communication.

*Nason, R.D., Phillippsborn, F.R., and Yamashita, P.A., (1974): Catalog of Creepmeter Measurements in Central California from 1968 to 1972, U.S. Geological Survey, Menlo Park, California, open-file report 74-31.

*Nason R.D., (1975): U.S. Geological Survey, Menlo Park, California, Personal Communication.

Nichols, D.R. and Buchanan-Banks, J.M., Seismic Hazards and Land-Use Planning, United States Department of the Interior, Geological Survey Circular 690, Washington, 1974.

*Nilsen, T.H., (1973): Preliminary Photointerpretation Map of Landslide and Other Surfical Deposits of the Livermore and Part of the Hayward 15-Minute Quadrangles, Alameda and Contra Costa Counties, California, U.S. Geological Survey, U.S. Department of Housing and Urban Development, Menlo Park, California, Map MF-519.

*Oakeshott, G.B., (1969): Geologic Features of Earthquakes in the Bay Area in Geologic and Engineering Aspects of San Francisco Bay Fill, Special Report 97, California Division of Mines and Geology, San Francisco, California, p 14-17.

Oakland, City of, Planning Department, Environmental Hazards, An Element of the Oakland Comprehensive Plan, Oakland, September 1974.

*From portion of Seismic Safety Element of the Alameda County General Plan, January 1976.

Pleasanton, City of Department of Community Development, Seismic Safety Element - Pleasanton General Plan, Pleasanton, January 1976.

Pleasanton, City of, Planning Department, Environmental Element of the Pleasanton General Plan, Pleasanton, January 1976.

Portola Valley, City of, Planning Department, Seismic Safety/Safety Element, Portola Valley, California.

*Radbruch, D.H., (1967): Approximate Location of Fault Traces and Historic Surface Ruptures Within the Hayward Fault Zone Between San Pablo and Warm Springs, California, U.S. Geological Survey, Washington, D.C., Map 1-522.

A Review of the Seismic Safety Element Requirement in California SSC 7701, A Report to the State of California Seismic Safety Commission, March 25, 1977.

*Richter, C.F., (1958): Elementary Seismology.

Rogers, T.H. and Williams, J.W., Special Report 107, California Division of Mines and Geology, 1974.

San Leandro, City of, Community Development Office, Safety Element of the San Leandro General Plan, San Leandro, California, June 1977.

San Leandro, City of, Community Development Office, Seismic Safety Element of the San Leandro General Plan, San Leandro, California, June 1977.

San Mateo County City-County Planning Task Force, Seismic and Safety Elements of the General Plan, Volume One and Volume Two, July 1975.

Santa Clara County Planning Department, Seismic Safety Plan, An Element of the General Plan Santa Clara County, January 1976.

*Seed, H.B., (1969): Seismic Problems in the Use of Fills in San Francisco Bay in Geologic and Engineering Aspects of San Francisco Bay Fill, Special Report 97, California Division of Mines and Geology, San Francisco, California, p 87-100.

*Slemmons, D.B., (1975): Cenozoic Deformation Along the Sierra Nevada Province and Basic and Range Province Boundary, California Geology, May 1975, California Division of Mines and Geology, Sacramento, California, p 99-199.

*Slosson, J.E., (1974a): State of California, Special Studies Zones, Dublin Quadrangle, California Division of Mines and Geology, Sacramento, California.

*From portion of Seismic Safety Element of the Alameda County General Plan, January 1976.

*Slosson, J.E., (1974b): State of California, Special Studies Zones, Niles Quadrangle, California Division of Mines and Geology, Sacramento, California.

Steinbrugge, Karl V., Appendix A - Comparative Building Damage.

*Steinbrugge, K.V., (1968): Earthquake Hazards in the San Francisco Bay Area.

Union City, City of, Planning Department, EIR for Proposed General Plan Amendment, Union City, March '81.

Union City, City of, Planning Department, Seismic Safety and Safety Elements of the General Plan, Union City, June 1975.

U.S. Department of Housing and Urban Development and U.S. Geological Survey, Studies for Seismic Zonation of the San Francisco Bay Region, Geological Survey Professional Paper 941-A, Washington, 1975.

United States Geological Survey, Seismicity within the Livermore Valley, California Region 1969-1979, May 1980.

*Wight, L.H. (1974): A geological and Seismological Investigation of the Lawrence-Livermore Laboratory Site, Publication UCRL-51592, National Technical Data Service, Springfield, Virginia.

William Spangle and Associates; F. Beach Leighton and Associates; and Baxter, McDonald and Company. Earth-Science Information in Land-Use Planning. Geologic Survey Circular 721. U.S. Geological Survey and Department of Housing and Urban Development, 1976.

*Wire, J.C., (1972): Geological and Geophysical Investigation Proximity of the Pleasanton Fault to the Walnut Grove School, Pleasanton, California, Report to Leonard Long and Associates by Jeremy C. Wire, Engineering Geologist, Santa Clara, California.

*Woodward-Clyde and Associates, (1970): Fremont Meadows Active Fault Investigation and Evaluation, Report to Fritz B. Burns and Associates by Woodward-Clyde and Associates, Oakland, California.

Woodward-Clyde Consultants, Phase II Evaluation of Geologic Problems in the County of Alameda, California, Woodward-Clyde Consultants, Oakland, California, 1975.

*Woodward-Lundgren and Associates, (1973): Phase I-Preliminary Evaluation of Geologic Problems in the County of Alameda, Report to Director of Public Works, County of Alameda by Woodward-Lundgren and Associates, Oakland, California.

*From portion of Seismic Safety Element of the Alameda County General Plan, January 1976.

*Wright, R.H., and Nilsen, T.J., (1974): Isopleth Map of Landslide Deposits, Southern San Francisco Bay Region, California, U.S. Geological Survey, U.S. Department of Housing and Urban Development, San Francisco Bay Region Environment and Resources Planning Study, BDC-63.

Yanev, Peter, Peace of Mind in Earthquake Country, Chronicle Books San Francisco, 1980.

Youd, T.L., and Hoose S.M., Historic Ground Failures in Northern California Triggered by Earthquakes, Geologic Survey Professional Paper 993, U.S. Department of Interior, 1978.

Youd, T.L., (1973): Liquefaction Potential of Unconsolidated Sediments in Southern San Francisco Bay Region, California, U.S. Geological Survey open-file report.

*From portion of Seismic Safety Element of the Alameda County General Plan, January 1976.